Cityplan '91

9 ENVIRONMENTAL BACKGROUNDER

Environmental Planning
Issues and Concerns in the
City of Toronto
Part 1

City of Toronto
Planning &
Development
Department

Robert E. Millward
Commissioner

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**Planning &
Development**
Department

Robert E. Millward
Commissioner

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"There is something fascinating about science, one gets such wholesale returns of conjecture out of such a trifling investment of fact."

Mark Twain.

"For every problem there is a solution — simple, neat, and wrong."

H.L. Mencken.

"Seek simplicity and distrust it." Alfred North Whitehead.

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Preface

The present work is produced as one of two complementary background documents. The ***Environmental Backgrounder Part I: Environmental Planning Issues and Concerns in the City of Toronto*** attempts to provide a synopsis of the environmental concerns and issues that are relevant within the urban setting of Toronto. The ***Environmental Backgrounder Part II: Analysis of Environmental Planning Policy in the City of Toronto*** attempts to provide an analytical review of those environmental policies that are currently to be found within the Official Plan and By-Laws of the City; to identify the policies and targets that are desired in order to satisfy the concerns and issues raised within Part I; and to identify what new directions should be pursued to achieve these goals.

The work is being completed as part of the 1991 review of the Central Area Official Plan. The findings and recommendations contained in this report are to be subject to full public review and discussion.

The basic purpose of the ***Environmental Backgrounder Part I - Environmental Planning Issues and Concerns in the City of Toronto*** is to explain the nature, cause and significance of the environmental concepts, concerns, and issues that are relevant to people in the City of Toronto. It is intended that the paper should satisfy these goals in an as accurate, balanced, and interesting manner as possible, and to do so without recourse to the jargon and shorthand of the underlying mathematics and sciences. The topics should be seen to be both "individually interesting", and yet sufficiently important and relevant to every aspect of human life and endeavour such as to be rightfully regarded as "collectively critical".

The objective of the Environmental Backgrounder Part I is, therefore:

- to clarify the issues and concerns;
- to make global concerns locally significant;
- to show the global significance of local actions;
- to be comprehensive;
- to present all sides of an issue;
- to show interactive component of issues;
- to identify "targets of concern";
- to evaluate "sustainable development" in an urban context;
- to clarify the role of urban environmental planning; and

- to ensure that all concerned citizens and Task Force members are aware that the Planning and Development Department has acknowledged a broader set of concerns than it may appear able to directly deal with under present jurisdictional constraints.

A deliberate attempt has been made to limit the inclusion of supportive data and referenced material. This has been attempted in the interest of intended brevity - albeit an interest not fully achieved for reasons of inherent environmental complexity, and in order to make it more readable (and less of an academic diatribe), for interested laypersons, both young and old.

Photo: Vince Pietropaolo

Executive Summary

Environmental Backgrounder Part I: Environmental Planning Issues and Concerns in the City of Toronto provides a synopsis of the environmental concepts, concerns, and issues that are relevant within the urban setting of Toronto. A subsequent and corollary document, *Environmental Backgrounder Part II: Analysis of Environmental Planning Policy in the City of Toronto*, will provide an analytical review of environmental policies contained within the Official Plan and By-Laws of the City of Toronto; identify the policies and targets desired to satisfy the concerns and issues raised within Part I; and identify what new directions should be pursued to achieve these goals.

The present document attempts to provide a simplified scientific background to assist readers in understanding the nature, cause, and significance of environmental problems. Issues and concerns are identified in the context of problems that relate to the quality and quantity of land, air, and water resources. The global significance of local issues and the local significance of global issues are also clarified. The role, scope and extent to which environmental planning has dealt, and may deal, with these issues in the future is presented. The extent to which the public's expectations that appropriate environmental action has been taken, and could be taken, to protect them and the environment, by means of planning initiatives and control measures, specifically at the City level, is also introduced.

Environmental planning has become an ambiguous "catch all" title applied to planning and management activities in which environmental factors are central. It should not be confused with environmentalism or with the preparation of environmental impact studies. Environmental planning covers an enormous variety of topics ranging from health issues in work places to global population and food supply problems. It can aid the City in two broad areas of environmental concern: one, securing plans that ensure environmentally compatible provisions of development subject to planning processes of development control and review; and two, identifying and protecting natural areas and environmentally sensitive areas through planning provisions.

Although other departments are involved with environmental planning issues and their resolution, one of the most important mandates of the Planning and Development Department is preparing the City's official statement of intentions and governing principles – the Official Plan, which will contain comprehensive and cohesive environmental policies.

Environmental issues are frequently over simplified and treated in isolation, which is all too often detrimental to the comprehension of their mutual dependency and interaction. For example, questions and concerns relating to the issue of dump site location and use are properly considered a land issue, equally, however, dump sites may have an effect on water by the leaching of contaminants into the water table, at the same time having an impact on air by the release of odours, dust, or products of combustion.

Environmental concerns have come to include those that relate to the preservation of scarce natural resources (largely organic), the conservation of depleting natural resources (largely inorganic), and the prevention and removal of pollution in the environment. The latter includes both the perspective of protecting the environment from the actions of humans, as well as the protection of humans from the actions of other humans.

The concerns addressed in the present document relate to the questions of environmental quality and natural resource quantity on a global, regional and local scale. For example, with reference to air, global issues, such as global warming and ozone reduction, regional issues, such as smog and urban micro-climate, and local issues, such as idling vehicles and sun shadowing, are addressed. In addition to presenting the local municipal significance of each, the document also points out that what may be identified as a global or regional problem has to be recognized as having local causes and solutions.

In a more general sense, air quality concerns relate to the presence in the atmosphere of substances that are the products or by-products of human activities, in concentrations that are toxic, irritant, or otherwise harmful to people, injurious to vegetation or animals, or damaging to artifacts, property or possessions.

Perhaps more noticeably than any other environment related issue addressed, is the fact that water is a joint quality and quantity concern. Clearly, minor amounts of pristine water are just as limiting as major amounts of tainted water.

The environmental issues addressed in respect to water within Toronto relate to such concerns as the safety and suitability of the available water for drinking, swimming, and industrial use. The associated questions of the content of effluents discharged into the waters, and the use made of the water, and the concerns for the survival of other species in polluted water are also presented.

The environmental concerns relating to land involve the conservation of resources (mineral, energy, food, farmland, or landscape), the disposal of wastes, the non-use of contaminated lands, and to the preservation of natural areas and lifeforms in environments that are free of pollution and other human impacts.

Land is often polluted by the activities of people. Equally, the continued existence of "natural land" is often threatened by the developments and thoughtless actions of people and society. However, several apparent land related environmental problems are in fact, integrated problems of the environment, involving land, together with air and water.

The focus of environmental concern as related to land is most commonly centred around local issues of resource consumption and pollution. Very serious global concerns are also evident. The concerns regarding land relate very largely to the environmental issue of the preservation of nature, the continued supply of, or replacement of the need for, certain resources, and to the environmental health issue of the safety of humans in contact with land.

"Sustainable Development" is not a new concept. It has been in evidence since before the turn of the century. The present day supporters of sustainable development, however, have seemingly come to applaud and adopt it as an appropriate principle of good business. It has to be recognized, however, that many present day environmentalists are dubious of the concept, and fear that what should perhaps be seen as "environmentally sustainable economic development" will be interpreted inversely as "economically sustainable environmental development".

The extent to which the City can regulate environmental impacts due to development depends upon the point at which it enters the development control system. At the last stage of the system, the building permit stage, the City's ability to secure amelioration or mitigation of inappropriate environmental conditions is restricted and effectively limited to ensuring compliance with the provincial Building Code, the Zoning By-law and other relevant applicable legislation.

The Committee of Adjustment deals with minor variances to the Zoning By-laws that are site specific. It has the authority to impose environmentally preferable conditions that might include, for example, landscaping and buffering measures, as to be required between non-compatible land uses.

The mechanism of Development Review is applied in areas that are subject to Site Plan Control under Section 40 of the Planning Act. In Toronto, Site Plan Control is applied throughout the Central Area and the major commercial strips of the City. Developers of new commercial industrial and residential projects have to enter into a development agreement with the City which covers such concerns as landscaping, lighting, garbage and waste disposal facilities, and disposal of storm water. Recently, powers have been expanded to include the provision by development proponents of waste management plans, and may come to include energy efficiency plans in the future.

The process of Subdivision Control (Section 50 of the Planning Act) allows for consideration of the health and safety of present and future inhabitants, and of the natural environment. It is a measure that may be applied for new large scale redevelopments that involve land use changes. As part of the Precinct Approval/"H" Removal process an environmental report and an environmental agreement must be submitted and approved.

Requested rezonings may either involve a change of declared City policy, in which case it must be accompanied by an Official Plan Amendment, or it may be a request for permission to develop structures and land uses as allowed under the Official Plan. Evaluation of the latter requires, in some instances at least, that consideration be given to the environmental impacts and remediation of such things as sun and wind conditions, soil conditions, and residential conditions, and land use compatibility. A noise impact statement is routinely required in all rezonings and has been a policy of Council for a number of years.

Whenever an Official Plan Amendment is required, certain environmental issues have to be addressed and reported upon by the developer. Such reports include the provision of noise impact statements; sun and wind studies; waste reduction and recycling plans; construction management plans; and soil testing, remediation and disposal plans where necessary.

Environmental Backgrounder Part II: Environmental Planning Policy in the City of Toronto will put forward recommendations concerning the provision of environmental policies and planning controls that collectively address the protection of natural areas, the reduction of pollution emissions and residues, the preservation of scarce resources, and the maintenance of pleasant ambient city environments that are clean, green and serene.

Introduction

The present high level of interest in environmental matters has its historical beginning in the conservation movements of the late 19th and early 20th centuries. However, the present environmental movement of the late 1980s owes more to the realization, in the 1960s and early 1970s, that pesticides and other contaminants could be harmful to the health of humans and to the environment itself, than it does to the earlier concerns of conservationists regarding resource depletion. However, today both philosophies are considered to be within the scope of "environmental" concerns.

Environmental concerns have come to include those that focus upon pollution, and upon the conservation or preservation of scarce resources. Any contamination of the physical, chemical, or biological characteristics of land, air, or water that detrimentally affects the health or well-being of people or other forms of life is referred to as pollution. Any reduction in the stock of natural resources that occurs at a faster rate than it can be renewed is referred to as a depletion of resources that warrants apprehension. Conservation and preservation are not synonymous. Conservation implies the wise and careful use of resources to ensure a continued economic viability or sustained yield; as such conservation seeks the maximum possible socio-economic benefits (gains) for present and future generations of people. Preservation implies the wise and careful protection of resources to ensure the continued natural existence or survival of wilderness areas and wildlife; as such preservation seeks the minimum possible costs (losses) for present and future generations of people.

Attempts to preserve and protect the environment from the widespread effects of human activity can only be appropriate and successful when based on a detailed understanding of the intricate web of interconnected biogeochemical cycles and physical process-response systems that prevail within our biophysical environment. Few of the facts involved are controversial. However, lack of familiarity with the holistic and dynamic workings of the ecological and environmental systems of the globe, together with the development of viewpoints that perhaps reflect personal considerations, has led to the creation of a considerable number of conflicting opinions regarding the nature, cause and significance of hazard to the natural biophysical environment.

In consequence, environmental matters can be thought of as "concerns" where consensus can be clearly identified, and as an "issue" where consensus is elusive. Thus, an environmental concern is a viewpoint that is not contentious and receives widespread support; this would be an apt description for the question of acid precipitation within Canada, though contention clearly exists elsewhere. An environmental issue exists, however, where viewpoints are contentious and/or no consensus can be identified, or has to be reconciled. Frequently, and as has been suggested by others .... the nature of conflict does not lie with the question of right and wrong so much as with the question of right and right.

Commonly, those who are on opposite sides of environmental disputes have strongly conflicting personal values. On some level, almost everyone admits or professes concern for the evident threats to the environment. However, enormous differences are to be seen between the perceptions of individuals about the nature, cause, significance, and solution to environmental matters. This does not imply varying degrees of honesty among individuals, but rather that there is sufficient scientific uncertainty about the speed, severity, and nature of the adverse environmental impacts, and the degree of benefit provided by various remedies, that it is possible for different people to reach different conclusions by varyingly weighting the importance of the available facts.

Less clear, however, is the reason for the fundamental disagreement that can sometimes be seen to surround and cloud scientific "description of fact", and around the interpretations made by so-called "scientific experts". A case in point, is the "issue" of nuclear power generation. Pro-nuclear experts, usually from the nuclear industry itself, rarely have expertise in matters of ecological response to radiation releases, yet they commonly predict that no ecological damage will result from "safe" nuclear power generation operations. Equally, anti-nuclear experts, perhaps with ecological training, rarely have expertise in matters of automated system response to nuclear "accidents", yet they commonly predict major failures of nuclear power generation safety systems. Two groups of so-called experts proffer contradictory advice. Who should the layperson believe? The answer in most cases is both. Value judgements have to made and the consequences accepted. Equally, personal preference, ethics or creed has generated everything from technocentric environmentalists, who attempt to manage the environment "properly", to egocentric environmentalists, who believe "management" is inappropriate and that people should only minimally meddle with nature. Perhaps, neither egocentric or technocentric environmentalists can be relied upon to be fully independent of their own preference when asked to provide scientific expertise. Further, it is a myth that science and scientists can remain solely objective and neutral from social pressures and perspectives in such matters.

Scientists, environmentalists and the general public may all disagree as to the severity of a problem and upon the value of a specific remedial action. For example, different people have different views of what is or is not to be considered as pollution; to some barnyard odours are objectionable but to others such odours are a requisite part of the natural environment that they enjoy. A person may even be seen to hold different opinions about pollution between their workplace and their home environment; some industrialists may manage "polluting industries" in urban environments during their working day, but are also perhaps adamant weekend environmentalists seeking preservation of threatened ravines, or seeking relocation of proposed landfill sites far from their homes or weekend cottages. People also tend to have varying standards, by space and time, as to what they object to as pollution. For example, a person may judge five minutes in a tobacco smoke-filled environment to be tolerable, whereas five hours might be judged intolerable. Such exposure may cause discomfort for some but could be life threatening for others, as, for example, if they were to suffer from emphysema. Equally, though five minutes in somebody else's tobacco smoke-filled environment might be acceptable, the same level of pollution when produced by others in one's own home might not.

People may also differ in what they regard as a pollutant on the basis of their assessment of the benefits and costs that accrue to their livelihood and well-being. If pollution control threatened the economic survival of a company, and hence the continued employment of its workforce, it would be unreasonable to expect a worker to impartially discount that personal loss against a more nebulous public gain as might be achieved by reducing the emissions of some invisible pollutant. Pollution may only be viewed as a minor issue when compared to a major loss of livelihood. Indeed, pollution control is seen solely in some quarters as adding to production costs rather than adding to community benefits.

The differences of viewpoint in these and similar matters has caused considerable divergence of opinion and interpretation in formulating policy with respect to the environment.

Issues and concerns, as are often expressed in the media and taken up by the public, do not always equate with scientific interpretation and expressions of concern. For example, in the early 1970s, scientists indicated a concern for the cause and consequences of global warming, but a sequence of cold summers and winters, in Toronto and throughout North America, in the mid-1970s encouraged a rash of media articles and stories detailing the coming of the next Ice Age. Perhaps one or two cool summers may again reverse the public's acceptance of those concerns that are attached to global warming. The reporting of the dangers associated with the depletion of stratospheric ozone has been on a roller coaster since 1983. Initial fears that stratospheric ozone would be depleted by as much as 20% were replaced as subsequent results from more general chemical-atmospheric models and studies forecast less severe depletions. The later reporting of ozone "holes" over the Antarctic and Arctic Regions, however, once again engendered concern and encouraged popular support for the abolition of Freon-using products. [Freon is the trade name of DuPont for CFC-12, or chlorofluorocarbon-12. CFC's are used in the manufacture and operation of such things as refrigerators and air conditioning units, the creation of blown-styrofoam products, and as cleaning solvents in computer manufacture.] Clearly, the media and the public may understandably be confused and develop a mistrust of such on-again off-again scientific pronouncements (or the media's sensationalizing of same).

A related issue is that few concerns or issues tend to remain for long in the public consciousness. A given concern, for which consensus is clear and may even come to be popularly regarded as "motherhood", is often thought to be solved and resolved as it passes from the headlines. For example, the public's new environmental concern, of the late 1960s and early 1970s, faded subsequently from the forefront of public consciousness, possibly in the belief that the newly established Departments and Ministries of the Environment would be sufficiently powerful to stem the tide of pollution and "stand-tall" against the previously current intransigence of the polluting sectors of society. However, ten to fifteen years later the public came to recognise that their hopes and aspirations had not been met, and at least partially in consequence of this, the question of concern for the environment has once again entered the public and political arena. Like so many other issues and concerns an item will be "hot" and in the limelight for only a short while before fading in intensity, and possibly disappearing altogether. The public may not, however, be so quick to forget again. Nor may they be so forgiving of promises that were made or implied, but neither implemented or adhered to, as they may appear to have been in the past.

The issues of contention that are presently in the forefront of the environmental movement include, but are not limited to the following. What is the inherent and intrinsic value of wilderness and wildlife? Should preservation of endangered species take precedence over economic vitality? Is nuclear power generation and nuclear waste disposal safe for people and the environment? Do we really need to use pesticides in order to feed the hungry of the world? What is the ecotoxicity of new chemicals introduced into the environment? Are such chemicals about to unleash a cancer causing epidemic? How severe are the adverse environmental impacts of our changing society, and how fast will they be realized? Is population growth or technological change the prime cause of environmental stress? Should we rely on the public or the private will to rectify the environmental problems of the present and the future? Do we have sufficient time to adapt to the consequences of predicted future environmental problems (such as global warming) before the predicted calamity overtakes us all? Should we be optimistic or pessimistic about our ability to provide the required "technological-fix" to the problems of the environment? Or should we develop ecologically sustainable relationships with our environment?

Many of the above questions are directly addressed throughout the following document. Others are addressed by implication, as for example, the question of: "do we take a pessimistic or optimistic view of the future?". That question is resolved, by implication, in favour of the optimists. To accept that the situation is hopeless and a lost cause would be to decry the purpose of the present document. It is clearly more productive and desirable to assume an optimistic answer, to seek out the most realistic viewpoint, and to invalidate the pessimistic scenario by taking such action as will make it redundant.

The present document attempts to clarify the issues and concerns not by polarizing the conflicting standpoints, but rather by expressing that which is commonly agreed between them, with such addenda as are required to clarify the disagreements only where it is judged to be critically necessary. As such, the document attempts to present a logical, rational and factual explanation of those environmental and ecological matters that are of concern, and at issue, among the people that live, work, and play within the City of Toronto.

Photo: Vince Pietropaolo

Photo: Vince Pietropaolo

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Air Quality

Global Issues

The changing physical nature and chemical content of the atmosphere is at once both a global concern, in that those who live at a distance may adversely effect the quality of someone else's local atmosphere, (and vice versa), yet also a local concern, in that every small, local, apparently insignificant, contribution may add up to a large, global, and significant, contamination.

Acid Precipitation

The issue has been well documented over the years and is, in essence, well understood. Further research is not needed to understand the nature of the problem. Though the full impact and consequences of acidic solutions on all materials has yet to be fully evaluated. However, the development and assessment of alternate fuel sources and other technological solutions is still beneficial, and ongoing.

The primary concern relates to the combustion of coal whereby oxides of sulphur and nitrogen are released into the atmosphere. Though the chemistry involved can be complex, in brief, the gases combine with water vapour that sublimate (change phase from gas to solid) to produce weak acidic crystal solutions, most notably the dilute composites of sulphuric acid, nitric acid, and nitrous acid. The artificially generated acidic ice-crystals that precipitate (as rain, snow, hail, etc.), augment the natural, carbonic acid induced, acidity of natural precipitation, and produce what is most commonly referred to as "acid rain" (pH <5.5).

Source areas do not always impact their own vicinity as severely as "downstream" areas. The acidity of precipitation in the Sudbury area was, until recently, a notable exception. The residency time in the atmosphere (chemically akin to the "hang time" of a punted football) of sulphur dioxide is of the order of two to three days. The movement of air masses from Ohio to Ontario, for example, usually takes two to three days. This permits the acid laden air to vacate the air space of the American

Mid West before precipitating in Canada or New England. The problem is exacerbated when the acid precipitation falls in environments that are lacking in those alkaline bases (e.g., lime) that could otherwise buffer the impacts.

In urban areas the impacts of acid precipitation is to leach and corrode buildings (including related pressure treated wood structures), bridges, and vehicles, as well as to impinge upon the health of all plant species, be they native or exotic, in natural areas, cultivated areas, or manicured gardens.

In Toronto, the most significant sources of sulphur dioxide (SO_2) are emissions from vehicles and heating furnaces. Whereas emissions from heating sources have declined significantly, the emissions from cars, buses and trucks has increased slightly. The annual average level of SO_2 as recorded at Toronto's three monitoring stations has been less than 0.01 mg/L for approximately the past 10 years. This represents 50% of the Ontario Ministry of Environment's (OMOE) standard criterion.

Proposed solutions to the issue of acidic precipitation include the use of low sulphur content coal, the adoption of different fuels, and the use of improved "scrubbers" to cleanse the air before it exits the smokestack.

Greenhouse Effect

The term "greenhouse effect" is an unfortunate misnomer because it does not, contrary to initial assumptions, act as the major cause of warming in greenhouses. However, the "greenhouse effect" does occur in the atmosphere. (The effect is preferably referred to as the "atmospheric effect", but common usage dictates continued use of "greenhouse effect".) That aside, the "greenhouse effect" is an insidious and serious consequence of inadvertent pollution of the atmosphere.

Concern stems from the release of those gases (most prominently, carbon dioxide and methane, less prominently such gases as ozone and chlorofluorocarbons) into the atmosphere that close out the longwave energy escape-route known as the "atmospheric window". The presence of the window permits wavelengths between approximately 8.0 and 14.0 microns to pass upwards through the atmosphere unimpeded, whereas at almost all other wavelengths, outgoing energy is absorbed by the naturally occurring gases (principally water vapour and carbon dioxide) of the atmosphere up to the limit of the wavelengths availability. Significant quantities of longwave radiation "escape" the atmosphere via the window, indeed the window occurs at the spectral zenith of terrestrial radiation; the maximum intensity of escaping radiation is in the vicinity of 10 microns. The presence of greater quantities of the "greenhouse gases" causes a progressive encroachment on the atmospheric window such that the "opening" is reduced, for illustration, perhaps to between: 10.0 and 12.0 microns. As less radiant energy escapes, the temperature of the lower

Photo: Vince Pietropaolo

atmosphere (troposphere) is raised. The troposphere radiates the energy, in part at least, back toward the earth. The earth absorbs some of the heat and is warmed, and subsequently the ground re-heats the air above it.

Some controversy and confusion attaches to the ranking of importance accorded the "greenhouse gases". The confusion stems from three interrelated aspects of heat absorption by gases. One, different molecules have different specific heat capacities, that is, similar quantities of added heat produce different temperature changes within different molecules. Two, gases absorb energy more favourably in some wavelengths than others, and are unable to absorb energy at all in still other wavelengths; for example within the atmospheric window, ozone absorbs most strongly at 9.6 microns. The significance of this is that when all the available 9.6 micron longwave energy that leaves the earth is absorbed, extra ozone released will not cause extra absorption and heating within the atmospheric window. Three, different volumes of each gas are added to the troposphere; for example, much more carbon dioxide than ozone is added to the troposphere and thus carbon contributes to greater warming.

More specifically, molecule for molecule, methane traps more heat than carbon dioxide; but more carbon dioxide than methane molecules are artificially released into the atmosphere; and methane absorbs in the shorter wavelength side of the window whereas carbon dioxide absorbs on the longer wavelength side. For these reasons, considerable care has to be taken with interpretations of greenhouse gas effect. Simply stating "greenhouse warming effect" as a function of volume released, or as a combined function of volume and specific heat capacity (this is the most frequent case), is inadequate.

However, historically carbon dioxide has been considered to have been artificially released into the atmosphere in greater volumes than methane and thus to have had a more significant tropospheric warming effect. Currently, though the scientific establishment holds carbon dioxide to be the more significant, evidence has been put forward to suggest that the release of methane could become a more significant future concern. Ozone is considered to be a minor "greenhouse gas".

The most important global sources of the "greenhouse gases" are the combustion of coal and other fossil fuels in the case of carbon dioxide and cattle rearing and rice paddy cultivation, in the case of methane.

In urban areas the impact of the "greenhouse effect" is not significantly different than that in rural areas. The "Urban Heat Island" effect owes its origin to greater sensible heat loss, and the blanketing by the pollution particles of the Urban Dome than the "greenhouse effect". However, the contribution to "greenhouse gases" by urban based industries and urban transportation forms is very significant.

Warming of the atmosphere can be interpreted both positively and negatively within the specific confines of Toronto. The greater warmth can be assumed to cause a lowering of the level of Lake Ontario, by an estimated 22 to 25 cms, and thus create problems for shipping entering the Port area. This is not a cause for undue alarm as the water levels of Lake Ontario can be artificially controlled. Further, and as a possible benefit, the greater warmth due to the greenhouse effect will also prolong the period of shipping through the Great Lakes, reducing the enforced period of inactivity, because of the presence of ice, to perhaps as little as two to three weeks, and thus generate longer and more intensive year round use of Toronto's Port facilities.

Greater warmth will also necessitate less energy to be used for heating in winter and more energy to be used for air conditioning in summer. The net effect is thought to be one of reduction of annual energy consumption. However, the global concern ought to be regarded as of paramount importance and a reduction of the greenhouse effect as the desired goal.

Proposed solutions in urban areas include using more fuel efficient furnaces and combustion engines, and more energy-conservation efficient buildings and vehicular use. Greater use of presently available alternatives such as electric vehicles (energy source notwithstanding) and the promotion of greater public transit and bicycle use are recommended, and the further development of such technologies as solar-hydrogen powered vehicles must be pursued. These measures would reduce the amount of carbon dioxide released into the atmosphere.

The City of Toronto has declared its intention to reduce the absolute amount of carbon dioxide emitted from all sources, and as a result of all actions, notably from combustion related processes of transportation, power generation, and heating, and within the boundaries of the City. The declared target is that there will be a reduction of 20% from 1988 levels, by the year 2005.

Ozone Depletion in the Stratosphere

The "ozonosphere" extends from the top of the troposphere (approximately 10 Km above sea level, but varies by season and latitude) through the stratosphere, to about 50Km above sea level, with a maximum concentration at about 25 Km above sea level. The ozonosphere "shields" the earth from certain wavelengths of the incoming shortwave radiation, specifically the near ultra violet wavelengths (0.30 to 0.39 microns). The significance of the shielding is that the human species has evolved without having to develop a defense mechanism against incoming ultra violet radiation. Should the shielding disappear, the incidence of skin cancer among the human population is expected to increase. Ultra violet radiation causes sunburn and certain kinds of skin cancer, including one termed ***malignant melanoma***, which is often fatal. On average a one percent reduction of ozone leads to a twofold

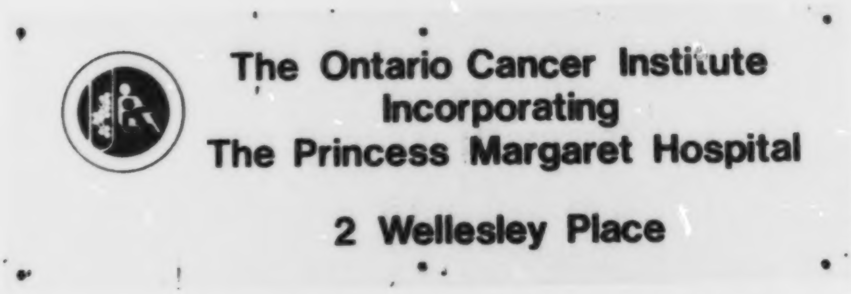


Photo: Vince Pietropaolo

increase of ultra violet radiation received at the surface of the earth, and to a corresponding fourfold increase in the incidence of skin cancer. Ultra violet radiation also causes a suppression of the human immune system, increases incidence of herpes infections, hepatitis, and other skin infections by parasites. Adverse impacts are also anticipated for agricultural crops and domestic animals, as well as for plant and animal wildlife.

A reduction in the ozone shield is presently occurring because of the release of ozone damaging compounds as produced in the manufacture and use of chlorofluorocarbons (CFC's), that drift slowly upwards into the stratosphere. The chlorine separates from the fluorocarbon, in a photochemical process, and disassociates the ozone which subsequently reforms as oxygen. One molecule of chlorine disassociates thousands of ozone molecules before drifting out of the shield area. The most notable areas of ozone depletion are over the polar regions where the concentration of various oxides of nitrogen (NO_x), coupled with photochemical processes are thought to have led to the destruction of ozone in such quantities as to create "ozone holes". CFC's are used in refrigeration and air conditioning appliances, as a component of cleaning solvents, and as aerosol propellants.

The proposed impacts of ozone depletion are common throughout the world (with the exception of the polar regions where the extreme case of ozone holes appear). However, it has been suggested that the urban pollution dome (see below) may diffuse the ultra violet radiation and make it less of a health risk for urban dwellers.

Proposed solutions (already implemented in some jurisdictions) include reducing the use of CFC's and banning their unnecessary use wherever possible. Toronto has implemented a CFC By-law as proposed by the Environmental Protection Office of the Board of Health. Technology has also sought alternate compounds that provide similar properties. Partially halogenated chlorofluorcarbons (HCFC's) are currently being suggested as appropriate replacements. They are said to have similar functionality but not to cause the destruction of as much ozone. It should be noted that HCFC's are still harmful to stratospheric ozone and should only be regarded as a temporary expedient.

Thermal Pollution

Wherever, and whenever, combustion occurs, heat is generated and lost. This may be a primary loss as from a home furnace , or a secondary loss as from electrical heaters. Whatever the insulation factor, ultimately heat is always dissipated along a thermal gradient. Heat lost from buildings and transportation vehicles enters the atmosphere as a sensible heat and radiant heat input. Similar heat exchange may enter via rivers and lakes where water is used for industrial cooling.

The global rate of consumption of chemically stored energy (i.e., fossil fuels and wood) has been increasing steadily at about five percent per annum. The rate of increasing fuel use in Canada is similar. Any percentage increase is an exponential curve of growth, and as explained by the pre-eminent Russian climatologist Mikhail Budyko, within 200 years, if the current rate of fuel combustion continues, the amount of heat released into the atmosphere per unit time will equal the amount received from the sun in the same unit of time. This has very clear implications for climate change.

The cause of the problem is very largely an urban centred one. The potential solutions relate to questions of policy and technology concerning the energy efficiency of buildings, and the energy efficiency of automobile engines and exhaust emissions. These questions are dealt with under separate headings.

Nuclear Holocaust/Nuclear Winter

It is anticipated that the energy and debris released in a global scale nuclear war will change the general circulation of the atmosphere and the resulting climate to the extent that any survivors would live under a blanket of nuclear dust. The "nuclear winter" would prohibit sufficient radiation from the sun being received at the surface of the earth to sustain life.

Solution to the problem will, hopefully, always remain obvious to everyone.

Regional Issues (Urban)

Microclimate

Cities modify the weather and climate of the three-dimensional space they occupy. The concentration of particulate and gaseous pollutants is often many times that of adjacent rural areas. The visibility and intensity of solar radiation, especially the shorter wavelengths, are diminished. The elements of temperature, humidity, wind speed and direction, and the occurrence and distribution of cloudiness, are all affected. (Precipitation is also sometimes added to this list but it is a questionable addition.) These modifications are the consequence of the built form (topology and change of surface), and the mass (pollution) and energy (heat loss) that are added to the environment. The most obvious changes of microclimate relate to the development of "urban heat islands", sun-shade issues, and wind regime alterations.

Urban Heat Island: The mean air temperatures within urban areas are on average 1 - 2°C warmer than those of the surrounding countryside. (This holds true year round as well as for day and night periods.) The effect is most obvious during periods of clear weather (especially three or four hours after sunset), at night, and at the coldest time of the day, just after sunrise, but the effect is present most of the time in larger cities such as Toronto.

Urban areas are warmer because a) during the day they are not cooled by the evapotranspiration processes that occur in rural areas (water vapour, and hence latent heat, is lost from the pores of exposed soil and the stomata of plants), b) the absorptivity and specific heat capacity of the materials of urban areas is greater than that of rural areas, and, in consequence, the nocturnal return of heat to the atmosphere is also greater in urban areas, and c) energy spent in the artificial warming, cooling, and lighting of urban buildings, is ultimately lost to the outside environment, thus the greater sensible heat loss from urban structures adds to the raising of urban air temperature.

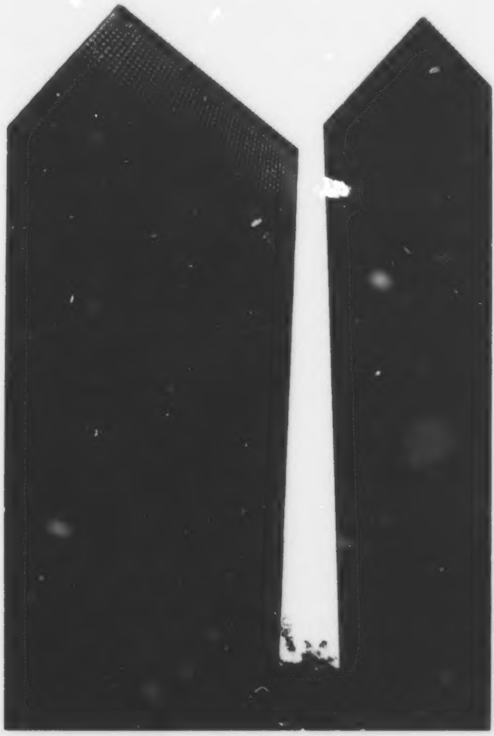


Photo: Vince Pietropaolo

The environmental significance of the urban heat island phenomenon is that it represents the regional expression of the global thermal pollution problem. Further, however, the additional heat released in the urban heat island has both positive and negative consequences. In winter, the heating requirements of buildings is reduced; the frequency, depth, and duration of snow cover is reduced; and, hence, the urban heat island reduces winter traffic snarls and lowers the cost of snow removal, and further, it ultimately reduces the quantity of salt disposed into the freshwater aquatic environment. On the other hand, in summer, the energy consumption of air conditioning is increased, but the humidity of urban areas is often five percent less than in adjacent rural areas and, therefore, the cost of dehumidifying is reduced.

In the particular case of Toronto, during the months of winter the urban heat island effect is usually clearly centred over the downtown core. However, in summer the downtown area is slightly cooler by day, and relative humidity is higher than surrounding rural areas. At night the heat island effect makes the downtown core warmer all year round than the adjacent countryside. There is also evidence to suggest that during the summer, the centre of the effect moves away from the downtown core and becomes centred over the intersection of Highway 401 and the Don Valley Parkway. These effects are due in part to the ameliorating influence of the lake and lake breezes.

There can be no absolute solution to heat loss in Toronto or anywhere else. Residents must heat their homes; heat will always escape. Relative solutions, however, could be implemented. Insulation acts to slow the rate of heat loss from human to atmospheric environments and is clearly to be recommended on grounds of resource conservation. Lower temperature settings at work and in the home will also facilitate the reduction of heat loss.

However, no environmental benefit ought to be looked at in isolation of the full system and this can be identified with respect to the topic of thermal pollution. The reduction of snow generated traffic problems, the reduction of snow clearance costs and the reduction of salt disposal into Lake Ontario might be regarded as side benefits that accompany thermal pollution and the urban heat island effect in Toronto. The net balance, with and without proper amelioration and mitigation measures, in respect of such things as snow-salt disposal, is unknown, and awaits further research.

Sun-shade Issues: Please see under Local Issues.

Wind: The wind in urban areas is usually lighter than in rural areas. This is because urban buildings create a greater drag on the air flow than occurs from the vegetation of rural areas. When wind velocities are small (usually taken as less than 8 Km/hr.), and this is the majority of the time, the frictional effect of the buildings is to reduce the air flow even further. Wind speeds are usually about 25% less in cities than surrounding rural areas. Conversely, when winds exceed some threshold (again, individual for each urban area but usually approximated as 8 Km/hr.), the winds are often made more turbulent and re-directed by buildings, funnelled along the canyons between buildings, and intensified on occasion to extreme velocities.

The environmental significance of the urban air flow is that when winds are light the pollution that is generated within city areas is not flushed horizontally. To some extent, however, the pollution is carried aloft to the upper portions of the urban boundary layer, as warmed air rises and is replaced by cooler air from the surrounding districts, or, and with specific reference to Toronto, by cooler air from the lake.

The City of Toronto has initiated a Physical Environment Study to examine the levels of pedestrian comfort as they relate to sun and wind on the streets and in the open spaces of the City. It is hoped that the study will help to generate standards that will insure that future development will contribute positively to pedestrian comfort.

Urban Canopy, Pollution Dome and Plume

The urban canopy is the built equivalent of the forest canopy. It is an imaginary surface that stretches over the tops of all the buildings of an urban area. Beneath the canopy the microclimate is distinct from that of the zone above. As such the air within the urban canopy tends to stagnate and become more heavily laden with contaminants than might otherwise occur.

The development of envelopes of polluted air that sheath a city has always been a by-product of urban growth, but one that became more serious with the advent of the industrial revolution. The situation has become much worse, however, as cities have become more massive. The pollution has come from the domestic and industrial activities of urban dwellers. The burning of fuels, (wood, coal, petroleum derivatives and natural gas), and the aerial release of by-products of certain industrial activities (smelters and steel mills) have been the most significant contributors.

The stagnation of air within the confines of the urban canopy, and in the urban boundary layer above, has come from temperature inversions and the lack of adequate flushing and mixing of the urban air mass. This creates an urban dome of concentrated air pollution. If moderate evacuation of polluted air occurs then the urban dome of pollution becomes an elongated plume extending in the downwind direction. (Plumes have been noted as extending, for example, all the way from Chicago to Washington, D.C.). If the air is not evacuated, then "smog" results.

In the particular case of Toronto, when winds are calm the city will sometimes develop its own wind system. The heated air in the city tends to rise, and air flows in from the lake (lake breezes) and the surrounding countryside (country winds) to replace it. These winds are usually light and shallow, but they may be felt as distinct breezes along roads that are orientated along lines toward the downtown core. Lake breezes may bring cold, moist air into the city, especially along the valleys of the Don and the Humber. This lake-induced and shallow temperature inversion creates a "lid" below which the city's smoke and pollutants tend to accumulate.

The quality of air with respect to the select contaminants monitored within the City of Toronto has been reported in *Toronto: State of the Environment*, a publication of the City of Toronto, Department of Public Health (1988). There are three OMOE monitoring stations within the City of Toronto that measure SO_2, CO, NO_x, and O_3. A fourth station monitors CO and NO_x. Total suspended particles (TSP) and lead (Pb) are also evaluated. Air quality varies across Toronto as a function of the location of local sources such as industries and major highways, and as a function of local influences (which may varyingly either concentrate or diffuse air) such as topography (built and natural), prevailing and dominant winds, and lake and country wind effects.

Using Ministry of the Environment guidelines as a basis for comparison, the ambient air quality in the City of Toronto is considered to be generally satisfactory by the City's Public Health Department (see *Toronto: State of the Environment*, 1988). The trends in the record of measured contaminants sampled across Toronto generally reveal downward or stable patterns with only occasional short-term upward fluctuations for the oxides of nitrogen. The exception to this pattern is the overall increase in the oxides of nitrogen and ozone as detected at three of the four monitoring stations. Emissions from all sources other than from automobiles, buses and trucks have been decreasing. Vehicle emissions have been increasing since 1978. It is anticipated that the provincial ambient air monitoring system and standards will be upgraded and that Toronto's air quality will subsequently improve. The potential for the City to undertake initiatives, especially with respect to vehicle use, is apparent.

"Smog" – Specific and General

Smog was initially a specific term coined to describe the combination of smoke and fog that became characteristic of certain industrial centres in North America and Europe. The smoke was produced, together with sulphur dioxide and fly ash, in the process of coal combustion. The fog occurred when the temperature of moisture laden air fell below the dew point temperature, and were often associated with temperature inversions above cities. "Smog" was a common occurrence in industrial cities such as London, Manchester, Pittsburg, Donora, and St.Louis. Exposure to "smog" was recognised as a health hazard that increased the local rates of morbidity and mortality. The passage of various national Clean Air Acts following the much publicised smog disasters of London (5th - 9th December, 1952) and Donora (26th - 29th October, 1948) did much to reduce the hazard.

A newer form of air pollution evolved in the densely populated, large-scale, sprawling, urban areas of such places as Los Angeles. The use of petroleum derivatives (fuel oil and natural gas for heating and electricity generation; gasoline, kerosene, and diesel for transportation) as replacements for coal and steam power has led to the release of effluents that are subject to photochemical reactions, where sunlight causes chemical changes and chain-reactions. Typically, in photochemical "smog", nitrogen dioxide absorbs sunlight, in the presence of hydrocarbons, to produce ozone and other highly reactive, irritant and toxic substances. This transformation is not immediate, but rather occurs as air drifts downwind and is subjected to solar radiation. Thus, in urban areas such as Metro Toronto, if the source of the pollution is taken as the downtown core of Toronto, the concentration of ozone is found to be higher in the outer suburban areas, such as Scarborough, than the source area.

Currently, "smog" is used as a generic term to describe all forms of air pollution, including the ambient stagnation of polluted air within the urban canopy, urban dome, and urban plume. The coal based "pea-soupers" are referred to as "London-type smog", and the "photochemical smog" of more recent time is referred to as a "Los Angeles-type smog" in deference to the cities where each was first observed. Reference is also occasionally made to "industrial smog", as below.

Pollution from Industry

Industrial smog consists mostly of a mixture of sulphur dioxide and suspended particulate matter (SPM), including a variety of solid particles and droplets of sulphuric acid. These substance tend to accumulate into a greyish haze, hence the term "grey-air cities". This type of smog was much more prevalent in the winter months in the older cities like London, Chicago, St. Louis, Philadelphia, and Pittsburg. These cities typically have cold, wet winters and used to rely heavily upon coal and oil for heating, manufacturing, and producing electric power.

The problems of industrial smog pollution relate to health hazards, property damage, and aesthetic impairment. The hazard to health is one of quality and quantity. The dangers of specific chemical elements and compounds are not discussed here. However, in Ontario, the Air Pollution Index (API) is used to indicate relative "safety" to human health. The API is based only on measured concentrations of particulate matter (aerosols) and sulphur dioxide. Currently the API does not incorporate any evaluation of the presence of hazardous compounds of arsenic, asbestos, cadmium, lead, or mercury. The API, however, will soon be augmented by an Air Quality Index (AQI) which is to include measures of several other pollutants.

The primary determinant of air pollution concentration is the amount of pollutant emitted. However, the concentration of pollution depends very clearly upon weather conditions and the physical configuration of the sources of the pollutants. The meteorological factors that affect the pollution concentration are a) the stability of air as determined by the vertical variation of temperature within the environmental air (i.e., the air around us) and the cooling of pollution carrying air parcel temperature as it ascends through the environmental air (i.e., temperature change without the addition or subtraction of heat, as due to pressure changes); and b) the

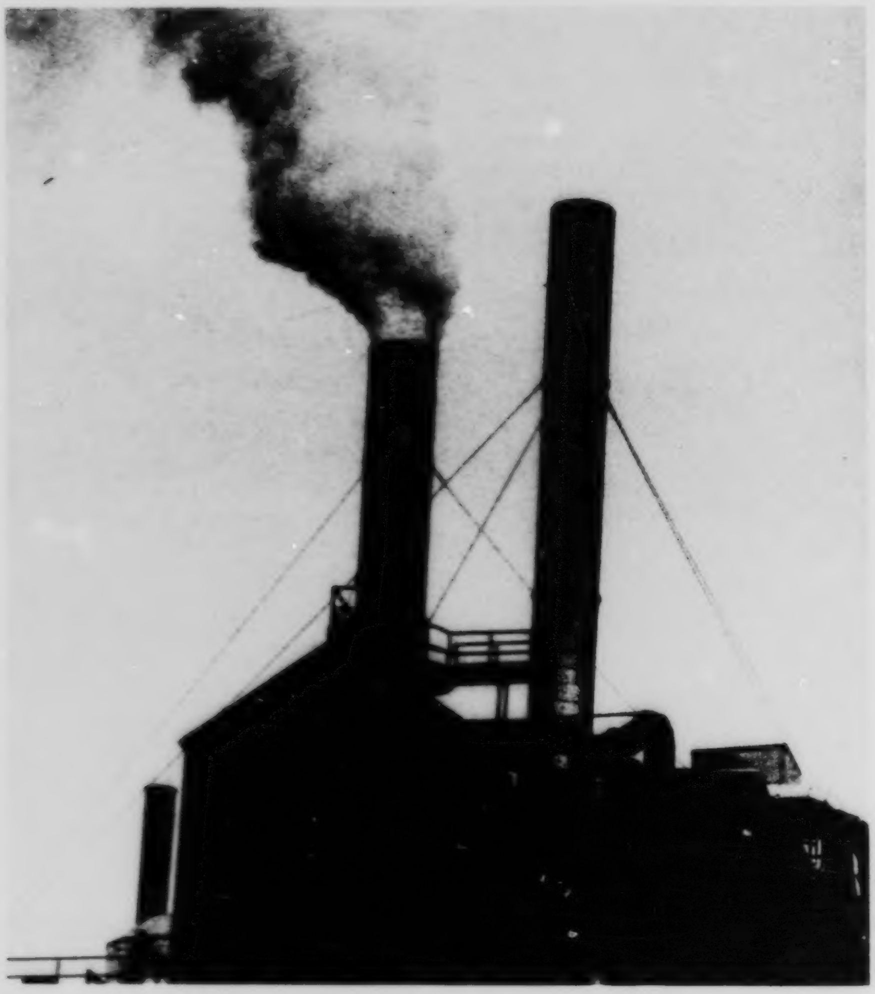


Photo: Vince Pietropaolo

direction and strength of the wind, (i.e., stronger winds as found at higher altitudes cause greater mixing and dilution of the pollution carrying air). The environmental significance of this is that pollution can be diffused in the atmosphere either by ensuring hotter emission temperatures at source (ideally these could reflect daily determined environmental lapse rates), or by building taller smokestacks. The latter is a far less effective, or certain a solution (though more economic) under all conditions, and, furthermore, is usually less visually desirable. Further, dilution should not be regarded as the solution to the pollution.

Pollution from Motor Vehicles

Exhausts: "Motor vehicles generate more air pollution than any other single human activity." (Gould, p.42, 1989). Cities generate more motor vehicle traffic than any other human structure. The issue of motor vehicle emissions in cities is thus central among environmental concerns. Worldwide, gasoline (petrol) and diesel burning engines contribute almost a half of the total carbon dioxide (though some authorities suggest that this figure is closer to a seventh), carbon monoxide, hydrocarbons, and oxides of nitrogen that are created by the burning of fossil fuels. Other products of concern as emitted by internal combustion engines include: airborne lead, sulphur dioxide, and carbon soot. The concern is for the health of individuals and for the health of the environment.

In Toronto during the period 1975 to 1978, as recorded in *Toronto: State of the Environment*, (1988, p.19-27), there has been little change in average CO levels or O_3 levels, a slight decrease in SO_2 levels, a slight increase in NO_2 levels, an increase of NO_x levels and TSP levels (due to vehicle emissions), and a reduction of ambient Pb measured as suspended particulates due to the introduction of reduced lead content automobile fuels. However, the emissions of SO_2, TSP, NO_x, CO, and HC due to vehicular use have increased.

Photo: Vince Pietropaolo

Carbon dioxide is a major contributor to the "greenhouse effect". Carbon monoxide is toxic and most likely to be harmful in confined spaces, such as underground parking garages. Carbon monoxide combines with haemoglobin more easily than oxygen and therefore, reduces the ability of the blood to carry oxygen, increases the risk of death due to heart failure, and impairs mental alertness and acuity. The poisonous quality of lead, especially with respect to children, is well known. The various oxides of nitrogen and sulphur also help create "acid precipitation". Some forms of airborne hydrocarbons are carcinogenic, but they can all react with oxygen in the presence of sunlight to form ozone, which is highly reactive and unstable, and exacerbates respiratory problems and inhibits the growth of vegetation.

Gasoline (petrol) burning engines emit chemicals that harm individuals and the environment in a largely unseen process. Diesel burning engines are more often recognised as a pollution source, emitting much soot. However, it is to be noted that diesel combustion is far more efficient than petrol combustion, and produces only one tenth of the carbon monoxide and hydrocarbon output of conventional gas engines fitted with three-way catalytical converters. Further, diesels require minimum adjustments throughout their lifetime to ensure a continued standard of low emission, whereas gasoline (petrol) engines need frequent adjustments and part replacements to maintain clean emission standards. Diesels produce less pollution than gasoline (petrol) engines, but the pollution that diesels do produce is much more toxic than that from gasoline (petrol) engines. Diesels produce a higher proportion of carcinogenic polyaromatic hydrocarbons and more carcinogenic carbon soot than gasoline (petrol) engines. "Diesel engines may be kinder to the environment than petrol engines but they are not as kind to people." (Gould, p.43, 1989).

The pollution that emanates from combustion engines does so because they do not operate (i.e., burn fuel) efficiently. The variation of temperature within a cylinder, the lack of complete mixing of fuel and air prior to ignition, and the difficulty of varying the fuel to air ratio with speed and load during operation, creates the inefficiency. These factors cause unburnt or only partially burnt fuel to be expelled from the engine. The problem can be rectified by either using filters to eliminate the contaminants from the exhaust, that is the post-combustion solution as adopted in North America, or by ensuring a more efficient combustion process, usually referred to as a pre-combustion solution, as being sought after in Europe.

Pre-combustion solutions are considered by many to be preferable because they cause fuel to be burnt more efficiently, and therefore, waste less of a limited resource, and also because they produce less of the "greenhouse gas" – carbon dioxide. Better ways of delivering fuel to the cylinders and igniting it at the right moment can be achieved by such means as replacing carburettors and distributors with microchip controlled electronic fuel injection and electronic ignition. (Such replacements are neither readily available in North America nor legal in Canada.)

This reduces emissions of carbon monoxide and hydrocarbons but does little to lower the quantities of oxides of nitrogen emitted. This can be done, for example, by adopting exhaust gas recycling (EGR), or lean burn, or turbocharger technologies in conjunction with electronic ignition and fuel injection. The "lean burn" engines, are so-called because by minimizing the peripheral quenching of the combustion flame and by promoting a more complete combustion, they can operate at a leaner ratio (fuel to air) setting. However, this technology is still in its infancy.

The post-combustion option is currently seen as the only workable system to meet present emission guideline levels in Canada. Catalytic converters and non-lead fuel has been accepted as the appropriate solution. Early converters were expensive, performance inhibiting, and required the more expensive lead-free fuel (lead deactivates the catalysts). More recent catalytical converters incorporate oxidation and reduction in a so-called three-way converter (TWC). In a TWC, palladium increases the oxidation of carbon monoxide and the hydrocarbons, and rhodium helps to reduce the oxides of nitrogen. TWCs also incorporate an oxygen probe (Lambda sensor) to monitor and regulate the volume and ratio of the fuel to air mixture. Modern converters do not restrict performance as did the early ones. Unfortunately, the perception among many "do-it-yourselfers" (DIYs) or weekend-mechanics has been that performance is improved by by-passing or removing the catalytic converters. The disadvantage of TWC's is their complexity and high price, their need to be coupled with a well tuned engine for the TWC to operate efficiently, their higher fuel consumption (because of richer mixture requirements), and their reduced durability under faster driving environments.

Perhaps the biggest problem related to the question of emission controls is that they do not work unless they are strictly enforced. Another problem is one of jurisdiction.

Motor vehicle standards, including engine regulations are a federal responsibility. The pollution problem, however, is often, very specifically a local (city) one. Whether national standards (of engine pollution control requirements) are a reflection of the average national needs or of the specific regional needs is a complex issue that is coupled with political and economic questions. If regional standards were deemed necessary then regional jurisdiction would be required—as in California.

Another relevant concern relates to the question of social equity. Attempts to improve car exhaust problems are cost related. Insistence on better maintenance of vehicles, or newer regulations concerning pre- or post-combustion processes are seen by some as a punitive solution. One that is seen to impact more upon the poor than the wealthy. Some might consider this as appropriate in as much as older cars tend to be the major polluters. However, older cars tend to be owned in larger numbers by poorer people, and therefore, any measure requiring frequent expenditure might be considered an inequitable solution.

Air conditioning freon loss: Freon (CFCs) are used extensively in automobile air conditioning (A/C) units. Such units are prone to leakage and many need frequent recharging. The "weekend mechanic" recharging kits rarely maximise the efficiency of the A/C units because they are pressure sensitive, and in consequence the A/C unit forces consumption of extra gasoline. "Do-it-yourself" installations often result in leakage and surplus freon being lost to the atmosphere.

Photo: Vince Pietropaolo

Furthermore, A/C equipped motor vehicles that are relegated to the scrap heap are rarely (if ever) drained of their freon before being left to rot. As such, the freon carrying tubes rust and, subsequently, permit freon to escape to the atmosphere. Automobile wrecking yards are probably the major source of freon contamination of the atmosphere. The significance of these observations is that freon is a major CFC based compound. Hence, freon losses add directly to the global scale problem of ozone depletion in the stratosphere.

Alternate Fuels: The use of non-petroleum fuels to reduce pollution from motor vehicles is receiving increasing support from both those who are concerned for the environment and those who direct the automobile industry. In the U.S.A. a recent Bill was passed to encourage automobile manufacturers to produce "dedicated" alternative fuel vehicles or fuel "switchable" vehicles. Dedicated alternatives imply a fuel with a greater than an 85% volume of methanol or ethanol. Fuel switchable vehicles are capable of operating on various blends of petroleum and gasoline fuels, or of operating on gasoline and natural gas. Pure hydrogen is also being touted as a future alternate to gasoline, but pure hydrogen, like pure carbon, is unable to deliver similar fuel efficiencies to the petroleum based mixtures. Solar powered cars have also been raced successfully across the Australian continent, and this perhaps indicates a future potential for similar vehicles in warm and sunny climates.

Colorado and California lead the movement toward adoption of alternate fuels with the introduction of more stringent air quality related legislation. Colorado and certain other states are implementing measures to encourage use of mixed fuels, that is with up to 10% ethanol or methanol in the fuel. California is also encouraging the use of pure methanol fuel. Recent evaluations of air quality emissions from alcohol fuelled vehicles suggest a wide range of results. Hence, the considerable controversy that exists with regard to such alternate fuel use, and this is especially true with respect to methanol fuelled vehicles. Pure methanol emits very limited amounts of hydrocarbons, and therefore, reduces the ozone pollution produced at ground level, but it does not offer much benefit in terms of carbon emissions. If methanol is blended with gasoline then carbon monoxide emissions can be reduced, but the ozone benefit is also diminished. Methanol fuels do, however, produce less carbon dioxide than gasoline fuels. Though, if the methanol is produced by converting coal into methanol, a doubling of the total carbon dioxide emissions is anticipated (after Ross, 1990). Natural gas powered vehicles emit less carbon monoxide and soot than gasoline powered vehicles, but produce more oxides of nitrogen, and barely reduce carbon monoxide emissions.

Electric vehicles essentially emit no pollutants. However, the electricity to power them must be produced somewhere and by some means. If the power is generated by means of coal combustion, the emission of carbon dioxide would remain or could even be aggravated.

The most environmentally desirable future fuel may be solar hydrogen. It does not create carbon dioxide, carbon monoxide or hydrocarbon emissions, and emission of the oxides of nitrogen are low. But, it does release water vapour, which is recognised as another "greenhouse gas" if released into the atmosphere. Extra water vapour in the atmosphere will not, however, cause global warming as severely as gases such as carbon dioxide.

GAIN
Regular Unleaded
61.5
MID-GRADE UNLEADED
63.5
Premium Unleaded
65.5

Photo: Vince Pietrapaolo

Fuel Additives: The addition of lead in gasoline acted to reduce secondary ignition within the combustion chambers of gasoline engines. That is lead reduced engine "knocking" or "ping" caused by a secondary combustion. The secondary ignition of the air-fuel mixture occurs because the first ignition event raises the temperature and pressure of the previously quenched (unburnt) gas to a state at which it will ignite. Lead prohibited such secondary ignition by lowering the upper temperature limit of combustion. The reduction of lead additives in gasoline can be compensated for either by raising the octane rating of the fuel, or by adding lead substitute products, most of which are manganese based. The process needed to achieve higher octane ratings requires larger volumes of unrefined petroleum to be consumed than if lead were added. [The petroleum industry currently uses C-ratings rather than the more dated octane rating system, but the latter is more universally recognised beyond the industry.] Though the risk to health of the combusted by-products of manganese based additives has been described as negligible by reputable sources (e.g. Hare's Royal Commission), questions remain in the minds of some. It is suggested that these additives are as harmful as the lead that they replace (see

PACE, 1985). The additives may either be added by the gasoline manufacturer, which usually implies appropriate trace-like quantities that are thoroughly mixed with the fuel, or as an after-market fuel additive product, which is less likely to be added in the correct proportions or as well mixed. Use of lead substitute additives ("octane boosters") are recommended by few (if any) manufacturers of pre-unleaded compatible engines, though products designed to maintain lower combustion temperatures are considered valuable in reducing valve wear on such engines.

Local Issues (Buildings and Open Spaces)

Climate and Building Design

Climate and weather are of importance in the design, construction, operation, and maintenance of buildings of all kinds. Prior to the present century, and throughout the world, buildings were almost universally in phase with their environment, and culturally distinct from one area to another. Currently, however, considerable similarity of design is seen around the world. This is especially noticeable in central business districts where the elements of the internal building climate (heating, cooling, airflow, light and humidity) are intended to be fully controlled. As such the external building design rarely reflects the natural parameters of the environment. However, a building designed for a warm, dry environment cannot be expected to operate at greatest efficiency in a cold, wet environment. The difference is seen, both in the additional fuel consumption within the non-climate-compatible structures, and in the corresponding additional pollution of the atmosphere.

Sun Shadowing

A traditional consideration in the design of a building or group of buildings is the effect of solar radiation. The direct receipt of insolation and its absorption is an obvious benefit in cold climates or seasons, conversely however, the same factor is a considerable disadvantage in warm climates or seasons. In an urban area (such as Toronto) the spatial geometry of the apparent solar path across the sky during a day and its variation through the year has to be understood and incorporated within the planning process. These factors are important for building design and massing, and for the appropriate development of open space. Traditionally, such questions are examined with the aid of noon-shadow diagrams as established for the times of equinox and solstices for a given development. It may be more appropriate on occasion, however, to monitor the solar fan by time of day and season. If approached properly the considerations go beyond simple geometry and include calculation of the radiation balance and heat balance. These require consideration of the absorption and reflection properties of the specific building and adjacent landscaping materials, as well as consideration of the associated sensible and latent heat flows.

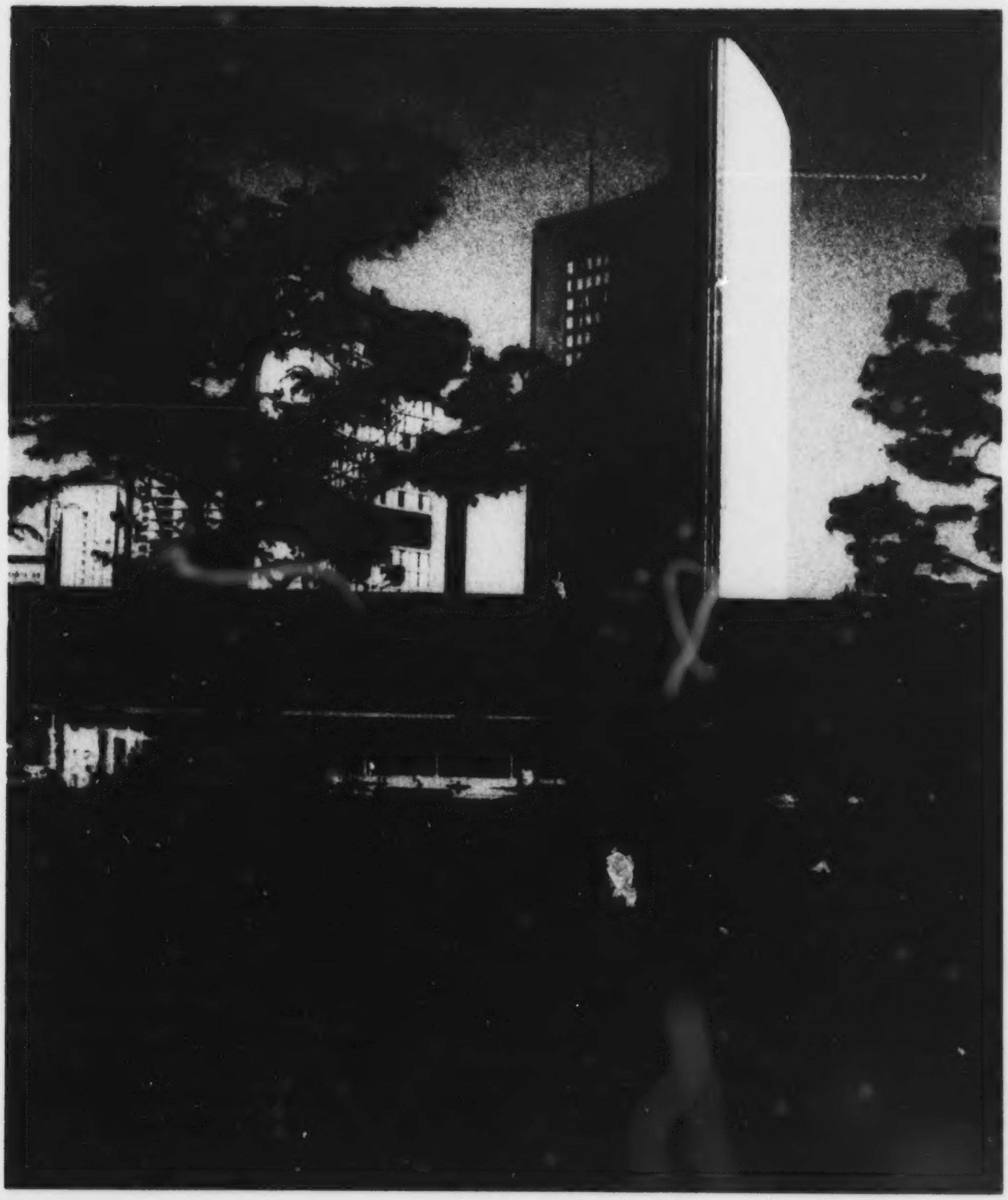


Photo: Vince Pietropaolo

Knowing the declination of the sun, and the zenith angle permits the simple calculation of the solar angle for any latitude and date, at sunrise, noon, and sunset (or any times in between). From this can be calculated the diurnal solar path. The influence of inclined surfaces can be calculated as ground sun angle. The solar heating of a surface can be calculated from ground sun angle, intensity of insolation, and surface albedo (the absorption ratio of incident radiant energy). For example, the solar angle for Toronto (which is at approximately 43.75° of latitude north) at noon on the day of an equinox is 46.25°. The equinox occurs when the noonday sun is overhead at the equator and everywhere on earth receives an equal 12 hour day and 12 hour night. This occurs on approximately March 21st and September 22nd of each year.

Solar energy can be harnessed in an active manner by use of solar panels and associated heat circulation systems. In the vicinity of Toronto it is common practice to pitch solar panel equipped roofs at 45° if the intention is to maximize insolation

Photo: Vince Pietropaolo

receipt at the time of an equinox. Systems may also, however, be designed to maximize solar gain during the winter months, in which case a steeper roof pitch may be adopted. Feasibly this may be as high as 67.5°, though a more moderate slope is most often used.

Solar energy can also be harnessed passively. Passive solar energy is harnessed through proper siting and landscaping, and by use of appropriate materials in the appropriate locations. For example, a highrise building with a southerly facing wall of glass that permits the solar energy of the day to reach interior heat absorbing walls is a passive system. The heat can then convect naturally through the building. Brick, concrete or containers of water are appropriate interior heat collectors.

In residential areas the use of shade tress and overhanging eaves to permit the rays of the sun to heat the buildings in winter, but to restrict the sun's rays access during the summer is well known.

Energy Efficiency of Buildings

The thermal environment within a building is obviously closely related to the factor of insolation receipt and absorption. The objective of a building is to establish and maintain an internal thermal environment that is conducive to internal use in respect of the external regime of weather and climate. The most important aspect in considerations of the thermal environment is the membranes that separate the internal and external environments (after Oliver, 1973).

The amount of energy required to maintain a specified internal temperature in a building depends on both the external temperature and the material of the walls that separate the two environments. The main concern is the flow of heat through the walls and roof in terms of both quantity and time. No wall or roof, however high its determined R-value, will prevent heat flow from high to low temperature areas, that is to say, nothing will prevent heat ultimately passing (being lost) from the inside to outside of buildings. However, if no heat were to be added to a building, it would take several days or weeks for internal temperatures to become comparable to the external temperatures. Thus, the heat flow is not instantaneous and there will be a time lag between the maximum outside and maximum inside temperature. The time lag can be very small or as much as eight hours. Beside the time lag there is also a dampening of the range of external temperature variation. Ideally the proper building materials are appropriate for the amplitude and phase of the external temperature. That is the additional (unwanted?) heat that is absorbed during the day, is held and not lost before the need for extra heat during the night is satisfied.

Toronto's office buildings and private residences are maintained at approximately 21°C during the winter. Architects usually attempt to create designs that overcome the coldest temperature that occurs with sufficient frequency during the average winter to justify its use. Although cloudiness and strong winds also influence the heat loss from buildings, air temperature is generally a much more pertinent measure for design purposes. In Canada, the winter design temperature that is most commonly used is the "temperature at or below which two and a half percent of the January hourly outdoor temperatures occur". This translates in the context of Toronto to a value of -17°C.

Heating engineers use an empirical approximation to estimate the amount of fuel required to heat the interior of a building to a level of 21°C during cold weather. The energy consumed is proportional to the difference between 18°C and the external temperature. The difference between 18°C and 21°C is assumed to be the contribution made by indirect heat sources, such as humans and their machines. Heating degree-days represent the addition of the number of degrees of "coldness" the mean daily value has below the 18°C threshold. Given a total number of 3,653 heating degree-days in Toronto's downtown core and 3,828 heating degree-days at Toronto's periphery (Malton), the difference (175 heating degree-days) represents the economic benefit of the urban heat island effect.

The increased use of air conditioning to reduce humidity and to cool internal air temperatures within buildings has become a much more significant practice in recent decades. The amount of energy consumed in air conditioning and cooling is, however, less than that required to heat the buildings in winter. The energy consumed is a function of the external temperature, humidity, and wind. There is a certain circularity to the problem in that the energy utilized to cool the internal air, plus the heat extracted from the internal air is first, lost to the outside air which being warmed, returns heat to the buildings, which in consequence must be further cooled. The design measure of "cooling degree-days" is not as well established as heating degree-days, primarily because there is no accepted method of calculating the measure in Canada. One that is used in the United States accumulates excesses above 16°C and is used in a similar manner to the winter equivalent of heating degree-days.

Wind Modification

The design of buildings and their grouping is seen to have evolved with affinity to the ambient wind conditions in several urban communities. This is most clearly seen where recurring local winds impact heavily on the population. The Mistral in the Rhone Valley, and the lack of northern exposure windows for example, is well known in this (deterministic) regard. Historically, in those areas that are not subject to frequent severe wind events, building design has not so clearly developed in response to such controls of climate.

A more extreme disregard for the local climate appears to have become established with the advent of modern highrise dominated city cores. However, this is not a totally accurate interpretation. Modern structures are designed to be internally independent of local climates. As such the severity of the local variations has to be considered in modern designs if a successful cocoon like entity is to be created. The "skyscraper" structures of modern cities have given rise to new found problems associated with the air flow changes produced by buildings interrupting and redirecting the wind.

Buildings are largely (but not exclusively) impermeable to air flow. Thus, air is deflected over, around, or down the front of these obstacles. The air "piles up" in front of the obstacle and creates a localized higher pressure field. Maximum pressure normally occurs near the upper middle portion of a wind facing wall, where the wind can be brought to a total standstill at the "stagnation point". Pressure decreases outwards from this stagnation point, and wind velocity increases accordingly. Near the outer edges of a building the acceleration of flow produces zones where the pressure is below the ambient atmospheric pressure, and suction results. If the buildings edges are sharp, with respect to the prevalent wind, a flow separation can occur such that the suction force is away from the walls and reverse air flow results. Significant lee eddy circulation zones are also created in the lee of buildings. These eddies may carry the pollution emissions from low smokestacks on top of such buildings or adjacent buildings into their lee wall zone. When the wind approaches a building toward an edge rather than a face, the same pattern of modification is observed, though the stagnation point is less clearly discernible. Building shape also influences the basic pattern of air flow.

When buildings are grouped together, the size, shape, spacing and orientation of each building effects in a gestalt-like process the flow pattern over and between buildings. If all the buildings are approximately equal in size, winds normal to the buildings produce vortex flow. (This is essentially an agglomerate of the lee eddy effects adjacent to individual buildings.) The wind at street level is usually less than if the space were open, though turbulence may be increased. Where buildings are at an angle to the wind the vortex becomes screw-like (helicoidal) with flow along the street. If the flow is parallel to the orientation of the buildings the wind is channelled and augmented so as to generate a jet-like effect.

If one large building is located among others of lower and more uniform elevation, the faster flowing air at the higher elevations is deflected down to the ground. Therefore, rather than being a sheltered environment it is instead an area of increased wind speed and turbulence (gustiness), especially within the area of the helicoidal vortex flow at street level. Such buildings can generate an environment three times as windy as in the open, and therefore, many times greater than in nearby sheltered streets (after Oke, 1978). Within Toronto, many streets and street intersections are notable for extreme wind speeds and turbulence occurring at ground level, for example, Bloor Street, and the intersection at Bay and College.

The Globe and Mail, E. Christensen, January 1978

An understanding of the air flow as modified by the built environment is clearly significant for the safety and comfort of occupants and pedestrians, and for the dispersion of air pollution. Cityplan '91's Physical Environment Study is intended to address these questions more fully.

Buildings are designed to withstand the maximum winds of a region such that they do not blow over. They are also designed to withstand the prevailing pressure differences between internal and external environments. These are harder to estimate, and in consequence it is reasonably common to hear of roofs or windows being "blown off". In fact they are usually not blown off, but rather sucked off. If outside pressures fall rapidly to markedly lower values than the internal environment, and the inside pressures are unlikely to have been able to change similarly because air exchange with the outside is deliberately restricted (indeed most high rise buildings are designed not "to compensate" but "to withstand" strong pressure gradients), then roofs and windows are subject to a combination of being blown out (from the inside) and sucked off (from the outside). Extreme low outside pressures occur adjacent to buildings because of the jet-like effects caused by the urban channelling of air flow.

The ability to open windows in highrise buildings is often desired by its occupants but the ability to do so is denied by the lack of opening windows. The reasons for this relate to the expense of replacing the heat lost in winter and, or, the humidity gained in summer. Assuming an interior temperature of 21°C and the outside temperatures in winter to be lower, but those of summer to be higher, and also assuming that all pressure differences are thermally induced, it follows (because warmer areas have lower pressure, and colder areas have higher pressure, and because air always flows from high to low pressure) that in winter air flow would be from outside to inside and in summer would be from inside to outside, until the pressure equalized. Thus, in winter exterior cold dry air would be gained from the outside, but in summer interior air conditioned air would be lost to the outside. If the air transfers were ones of simple air expansion there would be no exchange of inside and outside air, but usually where there is outflow there is a corresponding inflow and vice versa. If windward openings allow inflow but leeward ones are closed, the interior pressures are increased. Conversely, if leeward windows are open and allow outflow, as created by suction in lee eddy zones, but windward ones are closed, the interior pressures are decreased. This latter situation could logically be considered to be more likely. It would also be a situation in which the pollutants of the lee eddy would rapidly permeate the building. Another solution could, however, be considered. Pollution could be prevented from flowing back into the building if all buildings had taller smokestacks on their roofs – about 5 to 10 times taller than present.

Sealed buildings exchange air at ground level entrances. Internally the air is everywhere at constant pressure and temperature. Externally, however, the air temperature and pressure normally decrease with height. Therefore, at the top of highrise buildings a considerable difference of pressure and temperature exists between the inner and outer environments. Opening a window at the top of the building where previously all had been shut, could readily encourage a gale force air jet to flow rapidly in or out, with all its attendant safety hazards. Opening of interior doors could also become very difficult in consequence of the new internal pressure differentials. In some cities, however, architects are experimenting with windows that open in high rise buildings.

At ground level, where air flow is dynamically generated, the opening of building access doors can often be difficult because of the inequalities of inner and outer air pressures. Revolving doors are preferable to slab doors in that they work with any pressure differences rather than against them. Linking buildings underground with connecting pedestrian passages (covered ways) also requires consideration of balancing the various air pressure-temperature systems. Failure to do so, as in the Royal York underground access from Union Station, has been seen to result in considerable hazard to pedestrians, and repeated damage to the doors. That particular example has, however, since been rectified.

Street Noise

Because sound travels through air it is here considered to be a form of air pollution. Studies suggest that approximately 50% of all north Americans, mostly city dwellers, are regularly exposed at work and at home to levels of noise that interferes with communication or sleep. Workers who run a high risk of temporary or permanent hearing loss include: boilermakers; weavers; riveters; bulldozer and jack hammer operators; taxi, bus, and truck drivers; mechanics; machine shop workers, bar and nightclub employees, and musicians who use heavily amplified sound systems. Many people also self inflict damage by listening to overly loud home stereo or walkman devices. On the city streets the greatest noise source relates to transportation vehicles.

Sound is a physiological sensation received by the human ear. It is a rapid transmission of air pressure above and below atmospheric pressure. Basically, all sounds travel as sound pressure waves from a vibrating source such as a radio speaker, or a human larynx. The human ear is capable of sensing the fluctuations of pressure over a very wide range.

Sound is measured using the dimensionless decibel (dB) as the common unit. The pressure of sound is converted to loudness levels, where 0 dB is the threshold of hearing for a young person with very good hearing, and 120 dB is the threshold of pain. The decibel is measured using common logarithms, such that, for example, if one automobile produced 50 dB, two identical automobiles would produce approximately 53 dB. Each additional decibel represents approximately a 26% increase, so a gain of 2 dB represents a 52% increase, and a gain of 3 dB represents a 104% increase. A general "rule-of-thumb" is that if two sources of equal sound are combined, the result is a three decibel (3 dB) increase, which is perceptible to the human ear as a slight increase in loudness. An increase of 10 decibels is equivalent to doubling the loudness level. A decrease of 10 decibels is equivalent to halving the loudness level.

Noise is loud, harsh or unwanted sound. It may be unwanted for a variety of reasons: causing hearing loss, interfering with communication, causing loss of sleep, or because it is just plain annoying. Noise is considered to be an annoyance when sound levels increase above background or existing ambient levels.

Excessive noise cause both physical and psychological injury. Any prolonged exposure to high sound levels permanently destroys the microscopic cochlear cells in the fluid of the inner ear, which convert sound energy to nerve energy. Sound experts consider sound levels high enough to cause permanent hearing impairment if voices have to be raised to be heard above the noise. Traffic volumes, and the avoidance of cacophonous urban canyons must be considered near pedestrian orientated facilities.

In addition to hearing damage, sudden noise causes automatic stress reactions, including constricted blood vessels, dilated pupils, tense muscles, increased heartbeat, and blood pressure, wincing, holding of breath and stomach spasms. Constriction of the blood vessels can become permanent, increasing blood pressure and contributing to heart disease. Migraine headaches, gastric ulcers, and changes in brain chemistry can also occur (after Miller, 1988). Sudden noise on city streets is associated with emergency sirens, car horns, garbage collection activities, road repair, vehicles screeching to stop, or accelerating hard, and improperly muffled vehicle exhausts.

The unwanted effects of noise and vibration in a City may be ameliorated by establishing green spaces in neighbourhoods; by adopting acoustic insulation in buildings and adjacent to highways; by adopting quieter home-use external appliances (mowers and air conditioners etc.); by improving the quality of road surfaces; by improving tire designs; by improving technical processes and industrial installations; by installing noise suppressors and silencers (car mufflers etc.); and by locating noisy activities such as airports, helipads, railway stations, highways, car racing, rock concerts, and industry, away from residential areas; and at the house specific level, by locating bedrooms or quiet rooms away from highways or other noise generators, and by ensuring that such things as air conditioners are appropriately located with respect to both the owners and their neighbours.

Photo: Vince Pietropaolo

Massing and Density (Topology)

The size, orientation, and proximity one to another, of city buildings has clear impacts on many of the issues raised above. The interstitial spaces between the buildings of city environments contain and govern the urban wind and air pollution (smog), and also control its flow rate, direction, and dispersion; solar exposure and sun shadowing is also a factor of the spatial and topological relationships between buildings and their related structures; the recreational success of public open spaces and the use of passive energy technology in buildings is also a function of adjacent shadowing effects; energy efficiency issues in building membranes also relate to urban heat islands, pollution domes and plumes, and the global scale issue of thermal pollution; and last, but far from least, the relationships of buildings, and the mass and grouping of those buildings, in encouraging vehicle use and the various pollution forms that are generated by their use, are clearly evident.

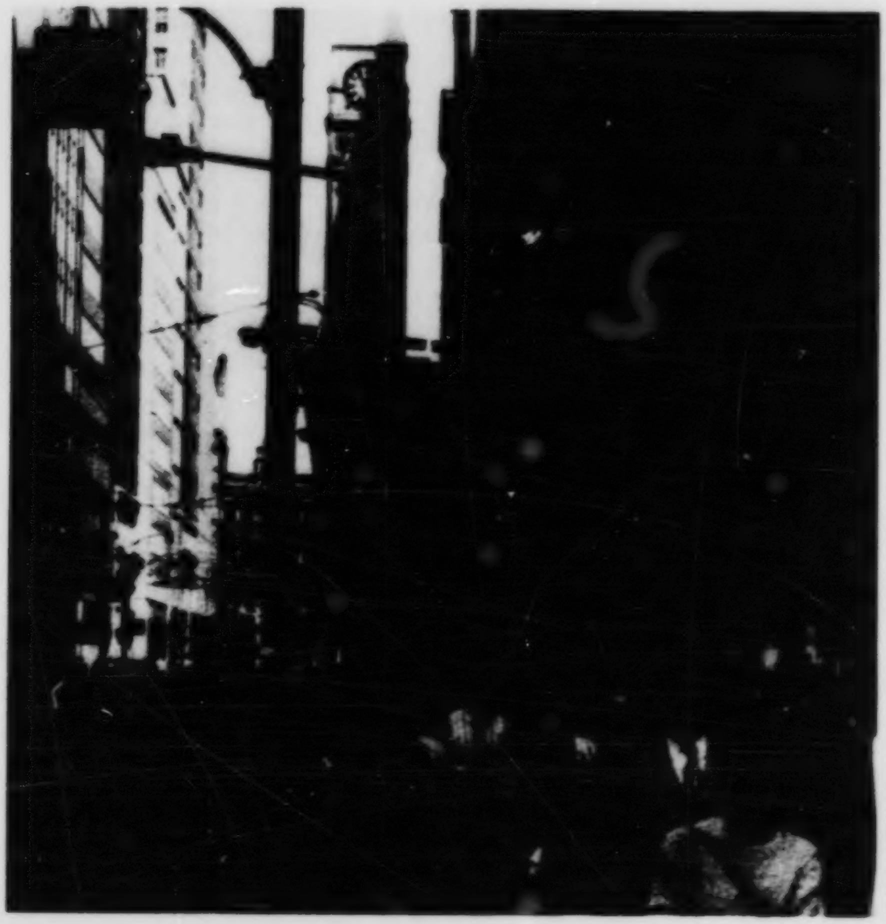


Photo: Vince Pietropaolo

2

Water Quality and Quantity

Quality Issues

"Water quality" is a term that is used in contexts that imply "cleanliness". However, the cleanliness of water is only one of the "qualities" that generate concern; other concerns may relate to water temperature, density, turbidity, phase, pH, or hardness (e.g., the toxicity of cadmium depends upon the pH and hardness of the water). "Pure" water is considered toxic to people. The chemical "purity" of water that is required by people, other species, and machinery varies greatly. Most people assume that the quality of drinking water is, or should be, of the "highest" standard. This, however, is not always the case. The requirements of high pressure steam power plants, for example, includes a total dissolved solids (salt content) in feed water of less than 1 mg/L, whereas the preferred total salt content of drinking water should not exceed 500 mg/L, though the Canadian standards are set at 1000 mg/L, and American municipalities may supply water with 20000 mg/L without complaint, (see Camp and Meserve, 1974, p.2). Further, though dissolved oxygen is corrosive to all metals, it is an essential component for aquatic life. Water that is polluted with a high level of human sewage bacteria is likely to contain disease bearing germs and viruses and is, therefore, unfit for drinking or swimming; however, aquatic species often prosper under such conditions; though, the fish, shellfish and plants that grow in such environments ought not to be considered safe for human handling or consumption.

Drinking Water

The most obvious reason for concern about the quality of water is related to the protection of public health, or, more specifically, the prevention of water borne diseases. Germs and viruses can be directly acquired, as when people drink the water, or indirectly acquired, as when people come into contact (e.g., by bathing) with contaminated water. The standard public health response is that: "water quality can be best assured by maintaining water clarity, a chlorine residual in the distribution system, confirmatory absence of indicator organisms, and low bacterial population in the distributed water." (Salvato, 1982, p.185, after the American Water Works Association, Disinfection-Committee Report, of 1978). Clearly, the prevention of waterborne human disease remains the most important reason for establishing water and sewage treatment plants.

The bacterial examination of drinking water normally includes a quantitative estimate of total organisms of the coliform groups, which are *indicative* of fecal contamination or sewage pollution. The total coliform groups of organisms include escherichia (E. coli), klebsiella, and citrobacter-enterobacter bacteria. Coliform bacteria are not normally considered disease organisms. However, pathogenic strains (disease causing organisms) of Escherichia coli have caused outbreaks in nurseries, institutions, and communities, that have been linked to contaminated food and water sources (after Salvato, 1982, p. 195).

As in many other industrial countries, the process of water treatment employed, as at the four plants in Toronto, is to rapidly filter the water using the established old

Photo: Vince Pietropaolo

(dating in principle from the 1920s) treatment process of sand and gravel filtration coupled with chlorine injections, referred to below as the sand and chlorine process. To simplify, the process works well to help eradicate the sources of those diseases (typhus, cholera etc.) that were of prime concern in the early years of the present century. The process removes the undesirable bacteria, as indicated by such organisms as E. coli, (plus others that often discolour water), and also works to remove the obvious contaminants, such as those sediments that create undesirable (on grounds of health or aesthetics) colour or odour in the water.

But, the process does little to remove many of the "chemical" products and by-products of the present day, chemicals such as: dioxins, mirex, polychlorinated biphenyls, toxaphene, benzo-a-pyrene, and hexachlorobenzene. Such chemicals are currently to be found in Lake Ontario. The City of Toronto, via Metropolitan Toronto's Works Department, extracts its water from Lake Ontario.

The Metropolitan Toronto Works Department tests for a wide range of chemicals that might be found in Toronto's drinking water approximately twice or thrice a year. Concentrations of contaminants are normally seen as being well below the provincial maximum acceptable concentrations.

The contamination of Lake Ontario water in the vicinity of Toronto, is thought to come from the Niagara River, because of leaking waste disposal sites, plus industrial and municipal effluent that is discharged directly into the river; various municipal sewers around the lake; combined sewer outlets; illegal connections; Metropolitan Toronto's Municipal Sewage Treatment Plants; Toronto industry (by special permit); plus dredging and lakefilling. The major source of contaminants to the Toronto Waterfront is sewage effluents from Metropolitan Toronto's four sewage treatment plants. As specified by the Board of Health

> *"...routine discharges are the largest source of chemicals and suspended solids to the Waterfront. Untreated excess flows, resulting from overburdened peak plant capacity during rainfall events, increase bacterial contamination. Recently, the Main Sewage Treatment Plant was found to be the largest source of heavy metals, organics and nutrients (phosphorous) to the Waterfront, in comparison with the Humber Sewage Treatment Plant, the Don and Humber rivers, and Mimico Creek."*
>
> (Toronto: State of the Environment, 1988, p.43).

The Ontario Water Resources Commission sets the drinking water objectives for the province. The guidelines cover a limited number of substances. More than half the number detected in drinking water have no guidelines at all. The limits that have been set are often based on either the limits of detection for the substance, or reflect the limits of the current water treatment facility, rather than a true reflection of desirable health standards. The limits may be technological limits or socio-economic limits.

Studies by Health and Welfare Canada, Ontario's Ministry of the Environment , and Pollution Probe have detected undesirable contaminants in Toronto's drinking water. These include: polychlorinated biphenyls, heavy metals, pesticides, halomethanes, polyaromatic hydrocarbons. Not all of these chemicals are a result of raw water pollution. Some are thought to be the products of the disinfection process or arise from the distribution system. The use of chlorine as a disinfectant, to control bacteria and algae, is questioned because if water is "chemically saturated" with the new chemicals, then adding chlorine to the water leads to the formation of additional chemicals, such as chloroform, and bromodichloromethane, which are considered to be carcinogenic. At issue here is that although chlorine removes much that would otherwise clearly endanger health, if permitted to remain, it also generates a carcinogenic risk. The distribution system also generates and permits additional contamination. "Older" lead connections corrode and release lead, "newer" plastic pipe also breaks down to produce vinyl chloride and carbon tetrachloride. Levels of boron, barium, copper, silver, and zinc have also been found higher "at the tap" than at the outlet of the filtration plant. Further contamination is thought to occur because of infiltration of contaminated groundwater into damaged or leaky pipes.

Problems associated with the current water treatment system in Toronto include the following:

- the raw water quality of Lake Ontario is low;
- the system currently employed is unable to remove many organic and inorganic contaminants;
- the guidelines of acceptable contamination may not reflect safety levels but rather reflect existing technology or political will;
- the chlorination (despite removing bacteria) may add unacceptable risk of cancer etc.; and
- the distribution system may add contaminants to the water.

The quality of drinking water can be improved by either ensuring the improved quality of the raw source material, or by improving the existing technology. To import water from elsewhere would be a very costly option. To rely on water pollution abatement measures would do nothing to resolve the present levels of contamination. [Though there are suggestions that PCB's may break down in the lake sinks in reasonably short time periods.] Further, continued use of chlorine as the disinfectant in the rapid sand and gravel filtration systems would still generate trihalomethane production. It is also beyond the jurisdiction of the City of Toronto to prohibit pollution being discharged into the upstream waters. The upstream river of most concern is of course the Niagara River, the quality of which is the concern of the International Joint Commission (IJC) and abutting municipalities. The immediate solution of choice for Toronto is thus to improve the existing technology at the treatment plants.

This is a Metropolitan Toronto area of jurisdiction, but Metro has always been sensitive to the concerns of individual municipalities, such as the City of Toronto in addressing these matters.

Some organizations have suggested that the sand and chlorine process should be replaced by an ozonation and activated carbon absorption process. Unless the carbon beds are very well maintained, and cleansed regularly, bacteria could rapidly build up to lethal levels. Here, rapidly means in the space of one or two days. However, this technique has been successfully utilised elsewhere, as in Europe, along the River Rhine, for over 25 years. It is also the water treatment process employed by brewers and soft drink beverage manufacturers in the Toronto region. The cost to convert to a municipal ozone and carbon system is estimated to be in the order of $10 to $20 per household.

Further, several of the European systems continue to utilise a small injection of chlorine to prevent bacteria build up within the distribution system. This should not be regarded as contradictory. However, the obvious utilisation of ozone and carbon, together with sand and chlorine, in a combined and integrated series has, seemingly, yet to be evaluated.

The quality of Toronto's drinking water is "generally safe", as defined by a federally funded study. It is indeed better than many western cities of comparable size. The water treatment processing plants are not, however, state of the art operations. The Toronto Public Health Department has made several recommendations regarding possible improvements. The changes to be implemented will presumably be a compromise between cost and health needs.

Water Quality in Natural Water Bodies

The City's natural water bodies include the Waterfront area of Lake Ontario, the Don and Humber Rivers, and the Humber Marsh. All have been negatively impacted by urban related activities. The Toronto Waterfront has been designated as an "area of concern" by the International Joint Commission. The phrase "environmental hot-spot" was coined by Pollution Probe and other activist groups, but has subsequently become incorporated within the Remedial Action Plan (RAP) initiative of the IJC. Some 42 "hot-spots" have been recognized throughout the Great Lakes drainage basin as potentially warranting improvement in their water quality. These "hot-spots" include the Toronto waterfront, Hamilton Harbour, and the Niagara River. The task is being undertaken in accordance with the Canada-Ontario commitment to the Great Lakes Water Quality Agreement of the IJC. The cause for concern lies with the variety and distant jurisdictions of contaminant sources, and the effect of the contaminants upon the natural biophysical aquatic ecosystem, and the human use to which such resources may be put.

WARNING
POLLUTED WATERS
SWIM AT YOUR OWN RISK
ON DUTY
CAUTION
AVOID WALKING IN BARE FEET
DANGEROUS DEBRIS

The Globe and Mail, Jim Lewcun, July 1989

The concentrations and chemical form of most pollutants change once they are added to river or lake water. This is because of four natural processes: dilution, biodegradation, biological amplification, and sedimentation. The degree of dilution of all pollutants and biodegradation of oxygen-consuming wastes by decomposers taking place in water depends on its volume and rate of flow. In large rapidly flowing water relatively small amounts of pollutants are quickly diluted to low concentrations and the supply of dissolved oxygen needed for aquatic life and for biodegradation of oxygen-consuming wastes is rapidly renewed. However, such water can be overloaded with pollutants. In addition, dilution and biodegradation are drastically decreased during dry spells and periods of low flow; or when extracted water is returned at higher temperatures, which decreases its dissolved oxygen content.

Dilution is less effective in lakes than in rivers because lake water contains stratified layers that undergo little vertical mixing. This also reduces the levels of dissolved oxygen at the bottom of lake waters. Dilution and dissolved oxygen replacement is also inhibited by the lack of flow. Dilution, as in Lake Ontario, is largely confined to the littoral margins and shallow surface layer. [Some 95% of the Lake is said to have a temperature within a degree of the freezing point on a year round basis.] Another problem with relying on dilution to disperse pollution is that substances such as synthetic organics, can have injurious effects on the aquatic ecosystem, and upon human life, at extremely low concentrations. Biodegradation is ineffective in removing non-biodegradable and persistent pollutants. Further, some pollutants, most notably those that are fat soluble, are biologically amplified to higher concentrations as they pass through the food chain. Sedimentation and flocculation can remove small traces of some organic and inorganic compounds from water bodies, but the sediments become heavily laden with such substances and any later natural or artificial disturbance of the sediments could produce hazardous concentrations (after, Miller, 1988). This question had to be addressed, for example, in determining whether or not the Keating Channel should be dredged of its contaminated silts.

In relatively shallow lakes, such as Lake Erie, or shallow empondments and embayments, such as the Toronto Inner Harbour, that are near urban or agricultural centres, accelerated eutrophication results. Eutrophication is a natural process whereby lake water becomes enriched with plant nutrients, such as nitrates and phosphates, as released by natural weathering and erosion and subsequently transported by run-off and rivers to the lake. Accelerated eutrophication, or cultural eutrophication, is produced by an over supply of phosphates and nitrates because of human activities. Accelerated eutrophication can be controlled by input control methods (greater phosphate removal from sewage and waste water inputs; reduction of phosphate usage in products; controlling land use and more regular "dry cleaning" of city streets) or by output control methods (chemical or physical weed removal; and aeration to avoid oxygen depletion).

Most natural rivers recover rapidly from many types of pollution loading because they flow rapidly. This is most obvious with excess heat and oxygen-demanding wastes, and is more true when the river is not chemically overloaded. The rate of recovery depends on the volume, turbulence, and rate of flow of the water, and upon the quality and quantity of the chemical inputs. Changes in the amount of dissolved oxygen throughout the course of a river produces differences in the type and diversity of fish and other aquatic species that are present. Rivers are especially susceptible to being overloaded with oxygen-demanding waste during hot summer months, when the volume, turbulence, and rate of flow is reduced, and the effects of dilution and oxygen transfer from the air are reduced. Dissolved oxygen levels are also reduced because the warm water holds less oxygen and increases the rate of bacterial decay. Many once rapidly flowing rivers have been converted into slower flowing non-natural entities by the construction of flood control structures. Slower flowing rivers are less effective in biodegrading oxygen-demanding wastes and dissipating inputs of heated water from industrial plants.

Rivers can also be the conduits for highly hazardous chemicals that are accidentally or deliberately released into the rivers and carried through downstream environments. Such scenarios are the normal content of local disaster planning schemes that are designed to preserve human life. However, such ecological disasters as was created by the Sandoz fire in Basle, Switzerland, and the subsequent passage of 30 tons of toxics into and along the River Rhine, in 1986, which impacted, and is still impacting, all the reaches downstream of Basle, are rarely if ever planned for.

Many rivers, such as the Don and the Humber, reflect decades of environmental neglect. The rivers and their sediments have been, and still are being, laced with excessive quantities of wastes from point and non-point sources. Toxics come from industries, combined sewer outfalls and municipal sewage treatment plants, as well as from residential neighbourhoods. Farmers are often judged to be the creators of most pollution by volume from non-point sources. Charges of excessive fertilizer and pesticide use are common. However, area for area, many urban gardeners, golf course operators, and recreational park keepers cause far more excess fertilizer and herbicide to enter the municipal water collection system than do farmers.

River contamination clean-ups, as in the Rhine and Thames, can be successfully undertaken, though they can never fully restore the former ecosystem. The spectacular clean-up of the Thames from being an anaerobic open sewer, to being a fish-supporting river, and this even includes pollution sensitive salmonids, is a notable example.

Another type of pollution that takes place in lakes and rivers is thermal pollution. Large rivers with fast flow rates can dissipate heat rapidly and suffer little ecological damage. But in smaller water bodies, and especially if they are slow moving ones,

Photo: Vince Pietropaolo

thermal pollution can be a significant concern. Warmer temperatures lower dissolved oxygen content. This occurs because the solubility of oxygen in water is reduced. Warmer water causes aquatic organisms to increase their respiration rates and consume oxygen at a faster rate, and it increases their susceptibility to disease, parasites, and toxic chemicals. Although some species can survive in heated water, many native cold water habitat fish, such as brook trout, are unable to tolerate such changes. Many species are unable to withstand rapid temperature changes, or thermal shock. Many fish also die on the intake screens used to prevent fish and debris from clogging heat exchange pipes. Pumping large volumes of cold, nutrient rich water up from the bottom layer of lakes, and returning it as warm surface water, after it has been used by a manufacturing industry or power generation plant as a coolant, also speeds up the eutrophication process (after, Miller 1986).

Water and Its Appropriate Use

Normal approaches to living with water pollution follow one or more of three directions. One, is to first establish the intended use for a body of water and permit pollution in types and amounts up to but not beyond a level that would infringe upon the intended use; and the second is to regulate the kinds and amounts of delivered pollution by means of rate-of-effluent-discharged-requirements, the latter are varyingly set for different industrial groups; and three, is to address the unsatisfactory condition that has already developed. Though all three approaches are often used in conjunction, the weight of concern shifts with the background of those imposing the regulations. Planning bodies tend to emphasise the first and third direction, and public health bodies tend to emphasize the second and third direction.

Quantity Issues

Urban Runoff

Urban runoff becomes a more notable problem as a result of storm events. However, such events also impact upon water quality. A considerable portion of urban related water pollution problems is attributable to storm water carrying sediments and pollution washed from urban surfaces. The make up and characteristics of urban surfaces are very different from those of rural surfaces. One of the most significant consequences of this is that city surfaces respond in a very different manner to storms, so that the runoff they produce is different in quantity and timing, with obvious implications for urban flooding, and flooding of downstream reaches of natural channels.

The problem of water quality is closely linked to the problem of urban runoff. The content of urban runoff in a city such as Toronto typically includes such pollutants as: petroleum products; salt used for de-icing roads in winter; organic materials from street litter; heavy metals; asbestos from brake linings; heat; phosphates, nitrates, and pesticides from parks, golf courses and gardens; oils and toxic materials spilled by industries; and bacterial sewage from animal sources.

The quantity of urban runoff is a problem that is currently addressed and "solved" by construction of roof drains, storm sewers, and major drainage networks. Little attempt is made to control the volume or rate of flow. Thus, the following three factors (after, Lang and Armour,1980) are all too often overlooked.

- Urban development increases the volume of storm runoff. Because of the presence of less permeable surfaces more water remains at the surface to flow elsewhere. Natural areas may have only 5% to 10% runoff; but if an area comes to be totally paved, as in downtown areas, the runoff can approximate 50% to 60% of the precipitated input.

- Urban development increases the rate of the runoff flow. The provision of drains collects and transports water very much faster than the natural soil and rock systems of nature. The time to maximum concentration is diminished, and the peak flow is also increased. In consequence, the construction of eavestroughs, downspouts, weeping tiles, concrete and asphalt gutters, catch basins, and storm sewers et cetera make flooding a more likely happenstance, and therefore, necessitates the construction of larger storm sewers and extra flood control structures.

  Straightening and lining channels, either above or below grade, with stone and concrete also increases the rate of flow, and also creates greater need for flood protection measures. Further, concrete channels cannot gradually cleanse itself of certain pollution. A last note, is that the increased rate of runoff detracts from the groundwater replenishment that would otherwise have occurred.

- Urban development and its consequence of increased volumes and rates of water flows, can lead to increased infiltration into sanitary sewers, and the need to by-pass sewage treatment plants during peak flow events. Increased water pollution adversely effects the use potential of the receiving waters. This has been demonstrated by the need to close down several of the beaches along the Metropolitan Toronto waterfront following heavy rainstorm events. Traditionally, the design of storm sewage and drainage systems has given priority to considerations of quantity rather than quality. The anticipated expenditures that are required in order to remedy such antiquated technologies as combined storm sewers is very high. It would require not only the provision of separate municipal drains, but would require that all downspouts from all residences and commercial establishments be linked to the new system.

Recently, certain urban municipalities have put their faith in the notion of "zero runoff" or "zero downstream change" for individual new development applications. The notions are scientifically misleading and imply an impossibility. In consequence, and among those who are responsible for ensuring "zero runoff", the term is interpreted as "no change of peak flow". That is to say the devastation of major floods will be no more severe following development than it would have been before it.

When an area is developed for housing or other urban purposes, the immediate hydrological effect is to increase the area of low or zero infiltration capacity and to increase the discharge rate and volume. Temporary on-site holding ponds may reduce flood peak levels but do little to reduce the ultimate downstream impacts.

Storm sewers also discharge untreated "peak flow" storm water directly into the Don and Humber rivers and Lake Ontario.

A further consequence of older urban development has been the combination of storm water and sewage water disposal in combined sewers. Combined sewer outlet discharges are normally treated at the municipal sewage treatment plants, however, as a consequence of rainstorm events the combined sewers become overloaded and the flow of untreated sewage and storm water is routed to discharge directly into natural water bodies. This is a source of considerable bacterial contamination, notably E.Coli, that leads to the posting of "swim at your own risk" warnings at many of the waterfront beaches. The City of Toronto has implemented a Sewer Program, since 1965, which has done much to improve the situation by separating sewers. However, the separation is incomplete (see City of Toronto: Sewer System Progress Report No. 4). Further, problems of funding or encouraging appropriate separation of internal household combined sewers and linking them to the appropriate sewer connections remain.

Human Occupation of Flood Prone Lands

Despite the inherent life threatening dangers, naturally flooding lands are frequently attractive areas for human settlement. As with so many natural hazards, the perception of the danger of flooding is appreciated, even heightened and exaggerated immediately following flood disasters. But as the flood lapses into history the interests of economic growth, development and local pride often come to prevail. Yet the flood hazard has not diminished. The occurrence of a 100 year storm in a particular year, in no way makes it less likely to reoccur the following year. Few people realise that flood control measures can never give absolute protection.

The Provincial Government of Ontario has the primary responsibility to develop policies affecting the regulation and administration of flood plain management in Ontario. This is undertaken by the Ministry of Natural Resources. The Ministry has established various Regulatory Flood volumes and levels across the province. In the case of Toronto the "Regulatory Flood" has been selected based on the Hurricane Hazel event of October, 1952. Specifically, although the event largely affected the Humber River watershed, it is assumed that a similar event could occur over the Don River, or indeed over any basin in the area. The extrapolation required in the case of the Don has resulted in a theoretical flow event that is approximately 10 times the size of the flow during the Hazel storm. This is also the largest flow ever recorded in the Don.

The main objective in selecting a Regulatory Flood as part of the flood plain management, has been to prevent loss of life and to minimize property damage and social disruption. The Regulatory Flood is the basis on which flood plains are bureaucratically delineated.

Within the City of Toronto, the floodplain areas of potential concern are the lands adjacent to the major rivers, the Don and the Humber, and the waterfront area.

Photo: Metropolitan Toronto Regional Conservation Authority

Historically, since the days of the earliest Toronto settlements, the floodplain areas, such as those in the lower Don, have contained property that has been owned and occupied. Today, such areas are dealt with as "Special Policy Areas". The Province recognizes that the Regulatory Flood standard may not always be feasible in those communities that have historically been wholly or partially located in a floodplain. Within such areas the ability to protect life and property is lowered as the accepted liability and risk of flooding is increased. The lower Don River floodplain is currently subject to a "Special Policy Area" evaluation. Once agreement in principle has been reached by all the interested parties (i.e. the Ministries of Municipal Affairs, and Natural Resources; the Metropolitan Toronto Regional Conservation Authority; the Municipality of Metropolitan Toronto; and the Municipality of the City of Toronto) an Official Plan Amendment will be prepared for Provincial approval, in which all requirements pertinent to the level of "dry protection", and required "wet protection" measures must be specified.

The anticipated frequency of a Regulatory Flood inundating the lower Don floodplain is extremely rare, but should one occur, the accompanying risk to life and the ensuing damage to property will be extremely high. The Province, however, regard the Regulatory event as a "likely" one, that should be protected against. In Special Policy Areas, where protection against the Regulatory event proves impossible or infeasible, a lower level of "dry protection" is permitted. This is permitted only in combination with more stringent "wet protection" requirements. Stipulated "wet protection" measures typically include such things as: no basements, and no underground parking; that is requirements are stipulated in order to minimize the loss of life in the event of flooding.

Photo: Vince Pietropaolo

3

Land Quality and Quantity

Preservation of Nature

The desire to preserve nature is a viewpoint that is varyingly based on ethics, morals, spiritualism, self-indulgence, and economics. It is a viewpoint that has been largely nurtured by the accelerating disappearance of natural areas around the globe. The disappearance of primary vegetation stands (for example, the old-growth pine forests of Temagami) represents a loss of habitat that goes beyond the loss of the trees themselves because it also encompasses the loss of the species association (including all animals, reptiles, and bacteria et cetera) within the ecosystem, and further, frequently impacts negatively upon endangered species in adjacent areas.

Natural Areas

In the vicinity of Toronto, natural areas have been largely replaced by farmland and replacement forests. The natural areas that remain are principally those of valley floor and wetland areas, and are representative of those areas that were deemed inappropriate for farming purposes. Thus, little of the native table land vegetation systems (Carolinian assemblages) are to be found. The ravine and wetland areas are, however, areas of primary vegetation. Elsewhere in north America, as in Missouri, the designated "natural areas" are secondary vegetation stands that have established themselves since the cessation of logging or farming activities. Such secondary vegetation may resemble the pre-existing primary vegetation, but most commonly large differences of composition and form exist such that they are properly seen and classified as distinct assemblages.

Natural areas can also be seen along the Toronto waterfront, and on the Toronto Islands. New land, as in the Leslie Spit, has also come to be naturally vegetated by pioneer and, subsequently, by secondary species. In the absence of development the area is likely to be a dynamic example of an evolving natural ecosystem.

The provincial and federal governments have undertaken, since the close of the last century, park acquisition programs that include components intended to protect dedicated wilderness and natural areas. Many local and regional governments (for example, Halton, Waterloo, Scarborough) have specified environmentally sensitive areas (ESAs) within their municipalities. ESAs are generally defined as those land or water areas that contain natural features or ecological functions of such significance as to warrant their protection in the best long-term interests of the people and environment of a specific region. ESAs are not necessarily protected by ownership but are designated as areas of concern, within which only limited and appropriate development is encouraged. As such, the effectiveness of the protection is only as strong as the political will in the face of each individual development application.

In most jurisdictions environmental resource areas (ERAs), where they are designated, are primary or secondary natural areas that are set aside as appropriate areas for education and scientific research. The City has designated publicly owned areas on the Toronto Islands as ERAs.

In the specific area of the City of Toronto, the major ravine waterways are under the jurisdiction of the Metropolitan Toronto Region Conservation Authority (M.T.R.C.A.). The M.T.R.C.A. has an ESA policy and has designated a number of such areas throughout Metro Toronto. The City of Toronto has jurisdiction over the smaller valley tributaries that feed to the larger rivers, and has established Ravine Policies to aid in their protection. The City's ERAs were initially identified as ESAs by the Metropolitan Toronto Regional Conservation Authority.

It is the established policy of the City that ravine lands that are owned by the City shall remain in their natural state, and that owners of other ravine lands shall be encouraged to maintain them in their natural state. It is further specified that public works undertakings shall only be permitted in ravine lands if they can be designated as essential; that Council will oppose highway and expressway alignments, and also constrain vehicular traffic on existing highways; and that tree or other vegetation destruction in ravines may only occur with Council approval.

Endangered Species

The designation of rare, threatened, extirpated, endangered, and extinct species of animal and plant life has been initiated and updated on a national and provincial level by the respective governments. Local lists of endangered species are often prepared by non-government ecological, ornithological, or other naturalist groups (for example, the Toronto Chapter of the Federation of Ontario Naturalists's). The terminology of the terms "rare", "common", "threatened" et cetera, is not synonymous between all levels of government.

The preservation of individual species is commonly a more pronounced and public environmental issue where and when the larger mammals, rather than insects and reptiles for example, are endangered.

The endangerment of species is not limited to deliberate habitat destruction, but can also result from unintentional pollution and consumption of the habitat environment.

It is the policy of Toronto City Council that management guidelines for ravines shall be adopted. Vegetation and wildlife management practices in the ravines are a prime component of this. The ravines have provided, at least to a limited extent, a refuge for the wildlife that previously existed on the tablelands of the region prior to the changes caused by agricultural and forestry practices. The vegetation of the tablelands and that of the ravines, though often very similar, is not identical in detail. The animal populations (including birds, fish, and insects et cetera) that are to be found within the ravines of Toronto are almost an "extraction" of the native assemblage, but one that has flourished by its proximity to human habitation. People, their wastes, and their pollution from such products as fertilizers and pesticides, have markedly altered the natural ecosystem of the ravines found within the city. Thus, rodents and other scavengers play a more significant role in the urban ecosystem than would be found in the absence of the urban structure of Toronto. This change of animal composition, has undoubtedly lead to the development of a new ecosystem of balance, that of an urban-natural ecosystem of people tolerant animal and plant species. That it only partially represents the pre-settlement pristine environment is insufficient reason to abandon its preservation.

Mineral and Energy Resource Depletion

Recognition that the consumption of limited (non-renewable) resources has negative impacts within the global environment has encouraged economies of use within environmentally aware, consumer orientated, local environments, and especially within urban environments. Toronto's blue box program typifies this economy of use.

Non-Renewable Mineral Resources

Recycling materials has a number of advantages. It extends the supply of those materials that are in short supply. It also usually saves energy, causes less pollution, less disruption of land, less waste disposal costs, and prolongs the life of landfill sites, by reducing the volume of solid wastes. For example, using scrap iron instead of iron ore to produce steel conserves iron deposits and saves 65% less energy, 40% less water, and produces 85% less air pollution and 76% less water pollution. Recycling aluminium produces 85% less air pollution and 97% less water pollution and requires 92% less energy than mining and processing the raw ore (bauxite). Despite these advantages, only about 25% of the world's iron and aluminium is recovered for recycling (after Miller, 1988), and it is estimated that approximately half of the aluminium beverage containers produced in North America are still discarded. Each discarded can represents a waste of energy equivalent to the same can being half-full of gasoline when thrown away.

Container deposit laws are increasingly evident and are considered to be effective in increasing environmental awareness and concern, as well as being an initiative to reduce waste generation that works. However, some bottle and can producing industries and their related unions favour litter-recycling laws, which levy a tax on industries whose products pose a potential threat as litter or landfill clutter. Most environmentalists argue, and present survey evidence in support, that litter taxes are not nearly as effective as beverage container deposit laws. They also point out that collecting and refilling beverage containers is more labour-intensive than producing new ones.

There are, however, environmental initiatives beyond reuse and recycling. These specifically revolve around "reduction" of resource consumption. The four "R" verbs: to reduce, to recover, to reuse (by repairing where needed), and to recycle, represent individual and distinct goals. The most important of which is "to reduce" resource consumption. This statement has obvious implications for everything from automobile use and office development to home construction and food packaging. Adoptance of the principle of reduction ultimately implies non-consumption and a very different socio-economic world than we now occupy.

Reduction can imply reducing unnecessary waste of limited resources, reducing the amount of material required per product (this implies, for example, smaller cars, smaller homes, or smaller numbers of paper consuming committees), prolonging product life, making products easier to repair, or permitting remanufacture of goods with reusable parts. It is asserted that the loss of profits and jobs in increasingly automated, machine intensive production will be more than offset by the increase in profits and jobs in labour-intensive service, repair, and recycling businesses.

It is to be remembered that ultimately there will be waste generated that has to be disposed of. This is dealt with in a later section.

Non-Renewable Energy Resources

The neo-Malthusian spectre of imminent doom and gloom, as the resources of the globe are increasingly depleted, found focus in the oil crisis of the 1970s. However, the oil crisis was not due to an actual physical shortage of oil. Rather, the shortage was deliberately manufactured.

The oil crisis in North America developed as the depletion of low-cost domestic oil deposits encouraged increasing dependency upon the OPEC countries for imported oil. The reduction of oil exports to Western industrial countries and the politically motivated embargo on exports to the U.S.A. in the 1970s generated a 500% increase in the average price of crude oil, double digit inflation, and global recession. Despite the price increase, the consumption of imported oil also increased. During the second phase of the oil crisis, when Iran effectively ceased production, prices again rose substantially.

The crisis resulted from OPEC's control of much of the world's supply, distribution, and price of oil. The response has been to attempt to reduce unnecessary usage and wastage of oil, and hence, to reduce reliance on foreign supplies of energy. The oil glut of the 1980s is considered to be only a temporary phenomenon. World oil use is projected to increase to the point, somewhere between 1990 and 2015, when demand exceeds supply.

Given the predicted oil shortfall it is evident that alternate energy sources and consumption patterns should be sought and adopted. There is considerable argument, however, as to which fuel source and related technology is the most appropriate to satisfy future energy requirements. Some experts call for greater use of non-renewable coal to produce electricity and high temperature heat for industrial processes and as a source of synthetic gas and liquid fuels for use in home heating and motor vehicles. Other experts call for greater use of non-renewable nuclear fission to produce electricity, and eventually for use of an almost inexhaustible nuclear fusion, when and if it can be developed.

Conservationists suggest greater use of either coal or nuclear power to be inappropriate. Instead, they call for strategies to implement greater energy conservation and efficiency of use, and ultimately to phase in greater dependence on a variety of renewable and perpetual energy sources based primarily on local resources.

There is also controversy about the need for comparable funding of energy reduction initiatives with energy producing initiatives. In other words it is held by some that public utilities, ought to consider funding schemes to reduce consumption in a city on an equivalent dollar per megawatt basis as employed to fund proposed extra capacity of production.

Most sources of energy are major polluters of the environment. It is a fact of life that we cannot produce, transport, or consume energy without creating pollution. The two are seemingly inseparable.

The alternates to oil that are considered include increased use of other non-renewable resources such as coal, shale and tar, natural gas, nuclear power, and geothermal, wind, solar, and bio-matter as sources of energy. Some of these would substitute directly for oil, others would do so in a more roundabout manner, often involving considerable and costly changes of equipment.

The central issue of the non-renewable energy question relates to credibility. Data and information have been frequently presented that appear contradictory. In large measure it is a problem of comparing apples and bananas. Is the world really running out of energy or can much more be found if the price is raised? Are environmental effects of energy use as serious and hard to manage as perceived by the energy industry or are there simpler and feasible solutions? Is there an ultimate technical fix or is that merely a product of wishful thinking? Do we have to chose between a clean environment and a growing economy?

The above questions can only be answered with difficulty and by making many assumptions. The selection of the assumptions adopted commonly reflect the particular pre-determined answer desired. However, it is difficult to properly assess the size and seriousness of the threat with the present available information.

The environmentalists response to the questions also varies from the technocentric (all problems are fixable) to the ecocentric (nature is too complex to play with). Perhaps the most appropriate view combines aspects of both beliefs, such that it be generally accepted that: polluting is an unpaid cost and is invariably cheaper than its prevention; it is impossible to pollute forever; and the nature of, and the distinction between, doing harm to environment and doing harm to human health via the environment must be clearly understood if the well being of both the environment and human health are to be maintained and/or improved. Further, and it is a view that is stated here with considerable trepidation since it is frequently misunderstood, or quoted out of context, is the understanding that it is not feasible, necessary or desirable to eliminate all pollution. Just as it is impossible to make an omelette without cracking eggs, so to it is impossible to cook the eggs without taking heat energy from somewhere. Any general and widespread use of such energy, be it derived from combustion, nuclear, or active solar capture processes is a polluting or resource consumptive activity somewhere along the line.

Coal: Coal is the non-renewable fuel which when used causes most environmental harm. The act of mining threatens the safety of miners with accidents and pneumoconiosis (black lung disease), and commonly creates pollution of air, land, and water. The burning of coal generates acid precipitation (rain, snow, etc.). This can be reduced by installing scrubbers in the smokestack emission process. Canadian technology exists to reduce acid precipitation causing emissions by 99%. This has yet to be universally adopted throughout North America.

Despite more stringent regulations, during the past ten or fifteen years the combined release of SO_2 (sulphur dioxide) has decreased but the incidence of acid rain has become greater. This apparent paradox is due to the implementation of regulations to encourage greater use of taller smokestacks and reduce emissions of fly ash.

The latter would otherwise act as a neutralising (alkaline) agent and reduce the acidity of the precipitation. [It may also relate to greater use of air conditioning in summer months when greater coal consumption occurs at times of high temperatures and higher absolute humidity.]

The burning of coal is a source of acid rain (SO_2 and NO_x), aggravated respiratory ailments (SO_2), and toxic pollutants (particulates). It is also the source of more greenhouse gas (CO_2) than any other fuel.

Oil: The mining techniques of conventional crude oil extraction, primary and secondary oil recovery, and enhanced oil recovery are not discussed here. Neither is discussion included of the technology employed in extracting heavy oils from oil shale and tar sands.

It should be pointed out, however, that oil extraction has environmental consequences. Shale Oil and Tar Sand processing requires large amounts of water, (this is scarce in those areas of the world that are richest in shale oil reserves). When the oil is processed and burned carbon dioxide (CO_2) is released into the atmosphere; without adequate air pollution controls nitrogen oxides (NO_x) and several possible carcenogenics are released. The mining and disposal of mine wastes (tailings) disrupts the land, especially in sensitive areas such as the Canadian north. Various salts and toxic metal compounds may be leached from the spoils into nearby water bodies.

The exploration of potential oil fields on land and in the sea may create unavoidable and accidental spills and gushers. The subsequent extraction of oil often has similar impacts. It is the transportation of the oil by pipeline and ocean tanker, however, that are recognised as the most damaging of the related oil industry activities. Some 60% of all extracted oil is shipped by tanker across the oceans of the world. Tanker accidents, such as those of the Torrey Canyon, the Amoco Cadiz, and the Exxon Valdez are the most visible and most reported, but the everyday spills are perhaps of at least equal significance. For example (and although the data is old it reflects the everyday problems that potentially remain), from January 1, 1974 to December 31, 1976, an average of 2.5 spills were *reported* to Environment Canada *per day*, with each spill averaging 160 barrels per spill.

The environmental costs of offshore exploration and transportation accidents are well known, in essence they lead to beach spoiling, and cause seabirds and other marine creatures to become coated with, and ultimately to drown in, oil.

The environmental damage that results from extracting and transporting oil is, however, far less than that which derives from burning it; and although the consumption (burning) of oil is a more benign activity than the burning of coal, it is done in such large quantities that it creates considerable environmental concern.

Oil is burnt in automobile engines, in oil-burning furnaces, in manufacturing and heavy industrial processes and in power generating plants. Such combustion contributes heavily to air pollution and global climate change by producing carbon dioxide (CO_2), oxides of nitrogen (NO_x) and sulphur (SO_x), hydrocarbons (HC), and particulate matter.

With the increasing use of less technically accessible and more geographically remote oil resources, the net useful energy yield of oil will diminish. As its price increases, its replacement with environmentally kinder sources of energy is a more meaningful possibility.

Photo: Vince Pietropaolo

Natural Gas. Natural gas is usually, but not exclusively, found in association with oil deposits. Normally, the methane (CH_4) rich (50% to 90%) natural gas is associated with propane (C_3H_8) and butane (C_4H_{10}) which are liquified and removed as liquified petroleum gas (LP). Very low temperatures can be used to convert the remaining natural gas to its liquified natural gas (LNG) state, which can be transported by specifically designed refrigerated tankers. However, LNG is extremely volatile, unstable, and flammable (any explosion causes a massive fireball) and conversion to LNG reduces the net useful energy of natural gas by 25%.

Natural gas has a high energy yield and is also relatively cheap. However, its price fluctuates with that of oil, and like oil, as supplies dwindle the attractiveness of more costly deposits becomes greater. These include deep rock zones containing deposits of hot water under such high pressure that large quantities of natural gas are dissolved in the water, coal seams, or shale deposits. The global resources of natural gas are considerable. Published estimates vary from 6000 to 10000 trillion cubic feet. The lower value of which, at current levels of consumption, would provide energy for 100 years. However, the gas is not equitably distributed among the nations of the world. For example, the U.S.A. has approximately 6% and Canada has less than 2.5% of global resources. It has been suggested that if Hearne Station (Toronto) is put into full operation it would consume one third of the available Canadian resources per year.

Natural gas essentially burns hotter and cleaner and is more environmentally friendly than any other fossil fuel. Burning natural gas obviously releases CO_2 but it creates less per unit energy than other fossil fuels.

Nuclear Power. Nuclear fission reactors produce none of the familiar pollutants that have made fossil fuels such a threat to climate and to clean air. The danger seen in nuclear power is that of radiation. Radiation in small amounts from uranium waste (tailings) at the mine and at the mill; from the operation of nuclear reactors, or from shipment and from storage of waste; and in potentially large amounts from nuclear reactor accidents. Exposure to radiation can lead to cancer, to genetic mutations, and in extreme cases to death. That much is certain, what is uncertain is the amount of the dosage that can be considered safe.

Confusion and controversy relates to problems of the size of dose, the frequency of exposure, and the elapsed time between exposure and its demonstrable effects. Other concerns relate to the use of water. Nuclear reactors consume about twice the amount of water that is consumed by coal plants. If and when the water is returned without being properly cooled then it can endanger the aquatic ecosystem.

The distinctive characteristic of concern regarding the nuclear danger is its potential to do harm rather than what has happened in the past. For some, as with many in the utility business, this makes comparison unfair and difficult.

The list of major nuclear accidents/incidents is considerable and the full list of occurrences and accompanying details have perhaps yet to be revealed. The worst ever was the disaster near Kyshtym, U.S.S.R., in 1957. The best known might be Three Mile Island or Chernobyl. The former was an incident, but one that not everyone agrees was significant, as it was a controlled and partial meltdown. Chernobyl on the other hand, clearly was a major disaster, which occurred when engineers turned off the automatic safety and warning systems in the interests of carrying out their research.

Major disasters are often described as examples of both what went wrong and what went right. For example, with respect to Three Mile Island, pro-nuclear forces pointed to the absence of severe damage in the aftermath of a massive failure, while anti-nuclear forces stressed the potential disastrous accidents and their unpredictability. In the case of Chernobyl, pro-nuclear forces point to the differences in technology with western establishments and the stupidity of removing safety controls, while anti-nuclear forces stressed that failure is an ever lurking menace. Apart from major disasters there have been many minor accidents and problems that have served to perpetuate public unease.

A further concern regarding emergency evacuation zones following a nuclear disaster is currently undergoing re-evaluation. After Three Mile Island a 16 km evacuation zone was adopted around all North American nuclear reactors. Critics wanted it expanded to 30 km as found around Soviet reactors, pointing out that the areas around North American reactors is usually much more heavily populated. In the case of a North American disaster many of the public would attempt to leave by automobile and would clog the evacuation routes. This did not occur at Chernobyl because few members of the public had automobiles. However, instead of expanding the zone the nuclear industry has been urging for a reduction of the evacuation zone to 1.6 km. They state that the danger is currently considered to be less than originally thought. A reduction of the evacuation zone required would permit utilities to locate reactors in zones that could not meet the stringencies of an acceptable evacuation plan. Within southern Ontario any major disaster would presumably lead to a "clogging" of transport routes in the bottleneck of roads approaching Windsor or bypassing Kingston.

Hydro Electric Power: The production of electric power by means of converting the kinetic energy of falling water, using appropriate turbines, has been around since the early 1800s. Currently, hydro electric power (HEP) provides about 25% of global electricity supply. In Canada we produce about 70% of our electric power requirements using HEP generation.

Hydro electric projects involve no combustion and no toxic discharge; if comparing them to the burning of fossil fuels – they appear relatively harmless, but HEP generation is not a totally benign operation.

There can be serious ecological and environmental costs that accompany the construction and operation of the requisite small or large dams. The costs might include a loss of water because of greater evaporation from exposed surfaces, an increase of river salinity, a change in streamflow and water temperature regimes which normally has negative impacts on aquatic ecosystems including unwanted potential inundations of weeds. Dams may also block fish migration routes and destroy pristine valley habitat. A further impact upon both the natural environment and the safety of humans is the propensity for landslides into the holding reservoir creating such shock waves as to initiate dam bursts.

Producing electricity from falling water, or its tidal equivalent, however, remains as an indirect source of perpetual (solar) energy.

Renewable Energy Resources

Large Scale Thermal Energy Conversion (oceans and lakes): Large bodies of open water store large quantities of heat from the sun. Experimental systems are being tested to use the large temperature differences between the cold bottom water layers and the warmer surface water layers of tropical oceans to produce electricity. Similar schemes have been proposed for electricity production within the Great Lakes. In a typical operation warm surface water would be pumped through a large heat exchanger and used to evaporate and pressurize a low boiling-point fluid such as liquid ammonia. The pressurized ammonia would be used to drive electricity producing turbines. Cold basal water would then be pumped to the surface to cool and condense the ammonia back into its liquid phase in order to re-initiate the cycle. The operation of the pumps would consume about one third of the power generated.

The production of electricity from ocean or lake thermal energy technology has the advantage of perpetual supply, again because it is a stored version of solar energy, and of producing no pollution. However, here again there are potential ecological and environmental aspects of concern. Nutrients brought to the surface as water is pumped up from the bottom will potentially cause blooms of unwanted algae, weeds or other lifeforms. Further, there will be a significant initial release of dissolved CO_2 into the atmosphere when large volumes of deep ocean water are pumped to the surface.

Currently large scale extraction of energy from the depths of the oceans, or large lakes, is unlikely to be economically feasible due to the high construction costs, high operating costs, high maintenance costs (in salt water corrosion will be severe), and the low net useful energy yield as energy transfer efficiency is only about 3%.

Small Scale Thermal Energy Exchange (solar ponds): Solar ponds are in essence simple water based solar collectors. They can be made to operate with saline water and to take advantage of the higher density of basal saline water to produce electricity, or to operate in freshwater environments as a source of hot water and space heating. The world's largest freshwater solar pond is in Georgia, U.S.A.. The 11 acre solar pond went into operation in 1985 and provides hot water for 6,500 people.

Solar ponds have similar advantages and disadvantages as ocean thermal energy conversion systems. However, they have a moderate net useful energy yield and do not cost as much to construct, maintain or operate. Freshwater ponds can only be considered as a community initiative in that they are too expensive and require too large land areas for individual home use.

Solar Power: The most environmentally benign potential source of energy is the sun. However, not all forms of solar produced energy are as equally environmentally gentle or economically feasible.

Passive solar systems sequester sunlight directly and convert it to low temperature heat. Architectural designs usually include sun exposed heat absorbing interior walls and an open design to permit air/heat circulation. A well designed passive solar system is the simplest, cheapest, most energy efficient and least environmentally harmful way to provide the space heating for a home or small building. Passive cooling can also be provided in summer with the aid of overhangs, awnings and trees. According to some experts in the field, climate sensitive, passive solar cooling and natural ventilation should make it possible to construct all but the largest buildings without air conditioning in most parts of the world.

Active solar systems for low temperature heat use specially designed collectors to concentrate, transfer, and store solar energy. Such collectors are usually mounted on sun exposed roofs and employ either circulating water, antifreeze, or air. Active systems are more expensive than passive systems, however, they are often cheaper to retrofit into existing homes. Active systems are also usually better for heating large apartment and commercial buildings which have large rooftops.

Using active or passive solar systems to heat homes and other buildings has a number of advantages. The energy is perpetual, free, and readily available (even on completely overcast days, albeit of reduced intensity); net useful energy is moderate to high and no release of carbon dioxide or other pollutants occurs. However, the energy is not available between dusk and dawn, and is much reduced during the depths of winter (thus requiring larger collectors) such that small conventional back-up systems are a prerequisite except in super insulated buildings. To work effectively most passive systems require owners to open and close windows and shades to regulate heat flow and distribution. As the timing of these tasks is important and can be both intricate and demanding on the time of the occupants, it is currently suggested that the operative process be controlled by microprocessor based systems.

Centralised solar energy capture schemes to produce high temperature heat are to be found, for example, in the concave mirror walled Solar Furnace at Odeillo, in southern France, or the Solar Power Tower, in the Mojave Desert, California. Many observers suggest that these schemes will make little immediate contribution to overall energy supply because they have a low net yield and are expensive to build and operate. They have low environmental impact air and water quality but they do consume very considerable acreages of land. They also require high availability of direct sunlight, and of water for cooling of steam if power is generated from turbines.

Solar energy can also be converted, using photovoltaic cells, directly into electricity. The amount of electricity produced per photovoltaic cell is very small. Large numbers have to be combined to produce a solar panel, and large numbers of solar panels have to be combined to produce electricity for a home or building.

Photo: Vince Pietropaolo

Solar cells have a number of advantages and disadvantages. They are reliable and quiet, have no moving parts, can be installed quickly and easily, need minimum maintenance, and last for long periods. They are made essentially from silica, which is the most plentiful of the earths resources, and then coated with boron and phosphorous. There is no combustion process involved and hence no occurrence of released CO_2 into the atmosphere. The production of air and water pollution during manufacture, when appropriately regulated, and operation is very low, and if roof mounted, land consumption is also negligible. On the other hand, the costs of solar panels are high and the net useful energy yield is moderate to low.

Wind Power. Arrays of small to large modern wind turbines that usually consist of spinning blades that drive a generator mounted on a tower are modern versions of the old windmills. The technology can operate in areas of appropriate wind conditions and can be mounted on individual roofs or in large wind farms. The latter consumes very considerable areas of land, and is often described as a form of visual pollution.

Wind power is a perpetual source of naturally converted solar and earth spin energy. Wind power has a moderate useful energy yield, does not emit CO_2 or other pollutants and has no cooling requirements. However, wind power can only be generated in windy areas, and consumes unacceptable quantities of land if centralised. Individual and site specific installations may, however, prove useful and desirable. Wind power is unlikely to become more than an auxiliary to other systems.

Biomass Fuels. Biomass fuel is organic plant material that has been created by the natural fixation of carbon, from carbon dioxide, and hydrogen, from water, and solar energy in the process of photosynthesis. The biomass can be burnt directly as solid (pre-fossil) fuel or converted into gas or liquid biofuels. Most biomass fuel consumption currently comes from the direct burning of wood and animal wastes. The energy is most often used to directly heat homes, water or to cook food rather than to be used indirectly following conversion into electricity. Biomass fuels can, however, be used to generate electricity and to power vehicles.

Biomass fuels are renewable as long as trees and plants are not harvested faster than they can grow back. They sequester carbon from the atmosphere and, therefore, there is no net increase of carbon to the atmosphere when they are burnt at rates equivalent to the natural fixation rate of carbon. Consumption of tree biomass, however, will return carbon that was removed from the atmosphere at a former time. Very careful budgeting of tree consumption should be undertaken where biomass fuels are consumed in order not to exacerbate the problem of excess carbon dioxide in the atmosphere. Without effective land use controls and replanting, extensive tree removal can deplete the soil of normally re-cycled nutrients, cause excessive soil erosion, water pollution, flooding, and loss of wildlife habitat.

Biomass fuels also have high moisture contents which reduces their net useful energy yield.

Wood fuel has a low energy content per unit weight, is expensive to harvest, transport, store, and burn. As a result in urban areas where wood has to be hauled long distances, it can cost home owners more per watt produced than oil or electricity. Residential wood burning also leads to considerable indoor and outdoor air pollution. Wood stoves emit large quantities of particulate, carbon monoxide, and polycyclic organic matter (unburnt carcinogen containing residues). Some wood stoves also cause creosote build up in chimneys and encourage house fires.

Another approach has been to create large biomass energy plantations where fast growing trees are grown and harvested. Some see this as a method of reducing carbon dioxide in the atmosphere and as a counterpoint to the pollution generated in city areas. Certain of these energy farms grow euphorbia plants (plants that store energy as hydrocarbons rather than as carbohydrates) which are later processed into petroleum products.

However, energy plantations usually require heavy use of fertilisers, herbicides and pesticides, and compete with high quality farmland for appropriate acreage. As a source of energy such biomass fuel has very low, and in the opinion of some – negative, net useful energy yields.

Burning agricultural wastes is usually neither efficient or desirable. In most rural areas agricultural waste are widely distributed and require large amounts of energy to collect, dry, and transport. Also by burning the waste rather than returning the residues to the land there is a loss of nutrients and fertility that will ultimately increase soil erosion and reduce the health of crops and livestock.

Burning urban wastes is traditionally seen as creating considerable air pollution. Certainly old incinerators can be considerable health hazards. Modern co-generation incinerator plants are believed by some, but not all, to be relatively "clean". Such co-generation plants burn the waste to produce high temperature steam and electricity either for industrial use or for sale to local hydro utilities. Certainly, burning waste reduces the volume of urban waste, and extends the life of local landfills and reduces the need for new ones. But some energy experts argue that more energy is saved by composting or recycling paper and other organic wastes than by burning them.

Biomass is also converted into liquid or gas fuels, such as biogas. In China and India, bacteria in (literally) millions of devices called biogas digesters convert organic plant and animal residues into methane fuel for heating and cooking. The remaining solid waste is used as a fertiliser. If the solid waste is non-contaminated it is used on food crops, if it is contaminated it is used as a fertiliser for trees. Biogas digesters are extremely efficient but are somewhat slow and unpredictable and are adversely subject to low temperatures, acidity imbalances and contamination with heavy metals, detergents, and other industrial effluents. Their use in India and China is declining.

Methane is also produced under anaerobic conditions at the lower levels of landfill sites. The gas has to be collected by inserting pipes. Most commonly it is either flamed or fed into on-site incineration operations.

The use of ethanol, which can be produced from the fermentation and distillation of a variety of sugar and grain crops, is being increasingly considered as an alternate fuel for motor vehicles. Pure ethanol can be burnt (exploded), to produce power, in modern car engines with very little modification. Gasoline can also be mixed with ethanol (usually less than 25%) to create gasohol, which is varyingly described as a super unleaded or ethanol enriched gasoline, that burns in modern engines without necessitating modification. Brazil currently leads the table of world automotive consumption of ethanol and gasohol fuels.

The production of ethanol creates large volumes of toxic residues (swill). It is only an economically viable fuel when produced in modern refineries. Its energy yield is moderate if tractor gas (i.e. energy consumed during harvesting et cetera) is not subtracted, and low if tractor fuel is included in the equation.

Methanol is also an alcohol fuel that is produced from wood, agricultural and other wastes. High concentrations of methanol corrode conventional engines but can be burnt satisfactorily in appropriately modified engines. Methanol is unlikely to be economically feasible until gasoline costs approximately $4.00 per gallon. Diesohol, a mixture of methanol and diesel, is still being evaluated but ought to reduce NOx emissions.

Hydrogen Fuels: Hydrogen naturally occurs only in trace amounts. Therefore, hydrogen would have to be first created in large quantities to be used as a fuel. Thus it must be produced with energy from another source. In accord with the first and second laws of thermodynamics, hydrogen production by any method will require more energy to produce it than is released when it is burned. Thus its net useful energy yield will always be negative and its use will depend on the ready supply of other energy sources. The highly explosive nature of hydrogen is a problem that can be overcome.

Hydrogen does, however, burn cleanly in the presence of pure oxygen, and creates no pollutants, indeed it only creates water vapour as a by-product.

Energy Conservation

The potential for reducing the amount of energy needed to heat residential houses, apartment high rises, and office buildings is considerable. It is not, however, limitless.

New buildings can benefit more readily from design changes, often with the aid of innovative technologies, such as: active and passive solar heating systems, major architectural changes (ground houses for example), than can established buildings. However, old buildings can also benefit, most often with the aid of more pedestrian technologies, in the form of: leak-plugging, increased insulation, double/triple/quadruple glazing, storm window installation, caulking and weather-stripping of doors and window frames, night-setback thermostats, energy efficient furnaces, and retro-fitting energy efficient lights (screw in ballasts for fluorescent lighting for example), and by using lower wattage energy efficient light tubes.

The cost of using an additional unit of energy to keep a home heated at a certain level of comfort is estimated by most analysts to greatly exceed the cost of achieving the same goal by a conservation expenditure (after Darmstadter et al., 1983). The comparison between these two costs is often the central issue of concern for those who are motivated by economics. As long as it remains cheaper to "buy comfort" by insulating rather than by burning fuel, then clearly conservation is cost effective. However, the one hundredth inch of insulation to the roof of a house costs just the same as the tenth inch of added material, but produces little if any cost savings. Therefore, in purely economic terms it is necessary to be aware of the dollar break-even point between under conserving, and hence wasting energy needlessly, and over conserving, and hence wasting insulation resources needlessly.

Changing wasteful habits can also generate energy savings: walking and bicycling rather than using private automobiles whenever possible; wearing warmer garments in interior spaces with lower thermostat settings during the winter and wearing clothing more appropriate for slightly warmer and less air conditioned interior spaces during the summer; and turning off unneeded lights and appliances all fall within this category. The option of reducing unnecessary energy waste can also extend to building and maintaining energy efficient automobiles and trucks, as is described elsewhere.

It is worth remembering that in the specific case of southern Ontario the bulk of consumed electricity is generated by HEP or nuclear means. Additional, occasional loads such as are required during the coldest periods of winter or the warmest and most humid periods of summer are met by increasing the coal fired generation of electricity. Thus, the marginal benefit of avoiding coal generated electricity is environmentally very significant.

Waste Management

Traditionally, local governments have assumed the responsibility for collecting and disposing of almost all domestic solid waste, old automobiles being a notable exception. The local jurisdiction itself usually owns the equipment and employs workers, or contracts private firms, to provide the service. In either case the service is paid for with local taxes and the quality of the service is ultimately dependent upon what the residents (taxpayers, voters) are willing to support and finance.

Photo: Vince Pietropaolo

One possible partial solution to the ever burgeoning supply of garbage is to view it not as something to be disposed of, but rather to view it as a useful resource. This is discussed under separate heading above. A further part of an overall solution is to properly plan and implement waste management strategies.

Metropolitan Toronto undertook to produce a long term waste management master plan for the disposal of its waste for a period of twenty to forty years. The Solid

Waste Environmental Assessment Plan (SWEAP) will identify the most acceptable systems for the handling, reduction, re-use, recycling, transportation, processing, and disposal of solid waste within the study area. It is intended that the plan should suggest an appropriate mix of alternatives that take into consideration the economic, financial, social, technical, land-use planning and natural environmental factors of concern. The Environmental Protection Office of the City of Toronto is also undertaking a Waste Minimization Program.

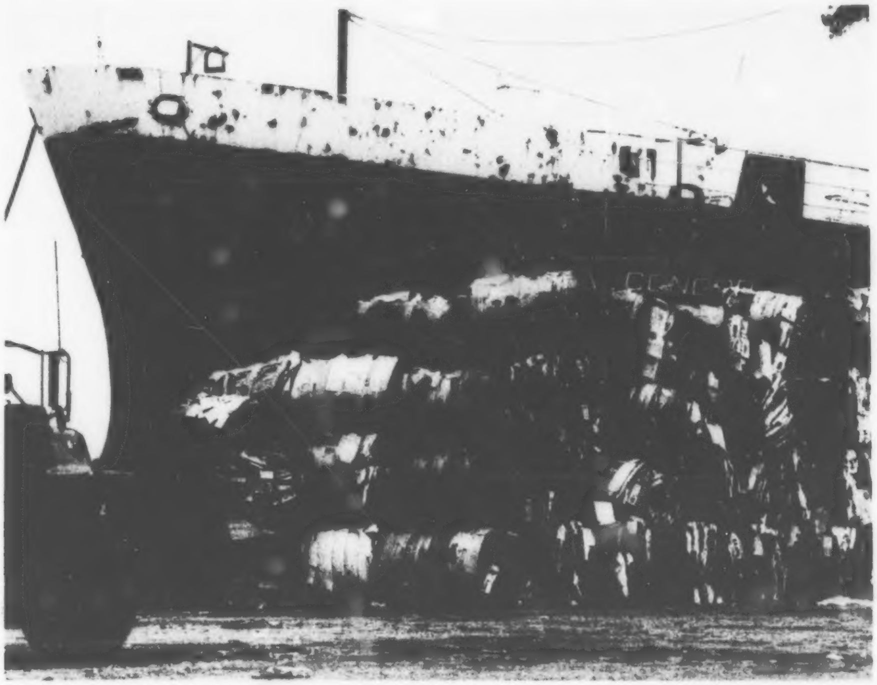


Photo: Vince Pietropaolo

Everybody wants their garbage picked-up. Most assume, incorrectly, that such pick-up equates to disposal. Few are willing to see the garbage disposed of anywhere near their place of work or residence, "not in my back yard" is a very real socio-political problem. Everybody wants the garbage picked-up, but seemingly, no-one wants it to be put down.

Various alternate components of a potential waste management strategy are presented below.

Dumps

Until relatively recently most municipal solid waste was disposed by the simple expedient of dumping wastes on open ground, or in disused quarries, or in specially excavated pits. Later adaptations included provision for daily/nightly burning of the waste. They were invariably the source of objectionable, and potentially toxic, airborne particulates, smoke, and foul odours. Burning had the advantage of reducing the volume of wastes and prolonging the life of the dump, but usually the burning was incomplete and the dumps had a life of their own in the form of rats, flies, and other vermin. Public awareness, objections, and recent air pollution legislation has led to the phasing out of the vast majority of such dumps.

Sanitary Landfill

Sanitary landfills have generally replaced local dumps as the municipal solid waste depository of choice throughout Canada. In a sanitary landfill, the wastes are dumped in a specifically excavated and clay lined, hole in the ground. Each day's dumping is covered with a layer of dirt and rolled to compact it; lime, or other chemicals, may also be added each day to absorb odours.

As long as each day's refuse is well treated and covered the landfill may be relatively clean and sanitary. Certainly, air pollution from smoke is eliminated.

When the capacity of the hole is reached the landfill is usually seeded, and becomes a municipal park or equivalent recreation area. Building on top of old landfill is ill advised as continued rotting of organics, and especially of paper products, within the landfill, inevitably causes settling. There is also considerable potential for continued methane release. This is a fire and health hazard long after the site has been closed.

In theory, domestic wastes do not contain toxic materials. Consequently, regulations governing the operation and closure of municipal sanitary landfill sites are not as stringent as the regulations that govern toxic waste landfills. One noteworthy cause of continued methane release, however, comes from the steady decomposition of baby urine and faeces bound up within slow-to-bio-degrade plastic diapers, as "disposed" in slow-to-decompose plastic garbage bags. (Slow-to-decompose/biodegrade here implies up to 300 years for complete decomposition, but sufficient decomposition usually occurs within 50 years for most of the methane to escape the bags.) By regulation baby diapers are not supposed to be put into sanitary landfill, and it is, therefore, most often assumed not to happen, and not to be a problem. Similar problems arise because of the illegal disposal by home owners of unwanted pesticides, cleaning solvents, paint, thinners, and other toxic compounds. Some municipal sites also suffer from the improper disposal of industrial waste material.

The most serious problem to be faced in sanitary landfill sites is that of leaching, which can cause groundwater contamination. Groundwater is normally recharged by infiltration of surface and soil water. Such water commonly contains various particles and microbes, including bacteria, that are physically filtered out or chemically removed in passage through the permeable material above the water table. Such "filtration" makes most groundwater suitable for drinking. However, the natural filtration process beneath sanitary landfills is rarely fine enough to remove individual ions and thus such water flows carry the ions in solution. Frequently, the design, construction, and resistance to failure of landfill liners, and the accompanying collection of leachates are all important for the health of nearby residents. (Potential causes of liner failure are discussed more completely in the section dealing with hazardous waste disposal.)

Though not the most serious problem, the problem of where to put new landfill sites is commonly the most politically sensitive and contentious. Local residents rarely want such facilities in, or near, their own backyards. Usually the operation of landfills is seen as seldom fulfilling the ideal solution as originally promised, designed and engineered. This is largely because of the difficulty in preventing refuse from being spilled in transit, or from being scattered by wind before it is suitably covered, and because of the difficulty in completely covering all the refuse in the landfill with a thin layer of dirt, on a daily basis, or because such covering is often removed by erosion. As a consequence, sanitary landfills tend to produce objectionable sights and smells, and are infested with flies and rats, though not as flagrantly as open, or open-burn, dumps. These problems as well as the potential for water pollution are realistic grounds for objection, as is the continuous traffic of garbage trucks.

Consequently, proposals for new landfills are frequently defeated by vigorous local interest groups. This encourages the acquisition of remote sites in areas of less dense population. However, all such proposals are equally subject to the Environmental Assessment process in Ontario. The problems of selecting new locations for the disposal of waste from Halton and from Metropolitan Toronto so as to satisfy the requirements of the Environmental Assessment process, and to satisfy the local residents are well known. The cost of due process is also expensive ($16 million for Halton to date). The problem clearly goes beyond the boundaries of individual municipalities in the Toronto area and the garbage problem for Metropolitan Toronto is currently being addressed at the level of the "super-region" of the Greater Toronto Authority.

Because of the lack of acceptable "urban" landfill sites many cities, such as Toronto, are turning to ever more remote sites. Cities purchase appropriately zoned land in other municipalities. To minimize the additional costs of ever longer haulage expenses, transfer stations are often established. Such transfer stations are designed to take local garbage and compact it, bail it, and put it on larger trucks or rail wagons for transport to regional sanitary landfill sites. However, finding appropriate sites to establish transfer stations is subject to the same process and objections as are the full-scale landfills.

Incinerators

Recognition that landfill consumes ever increasing acreages of land, often pollutes the adjacent land areas, and necessitates environmentally and financially expensive haulage costs encourages the view that in-source-area disposal facilities should be encouraged. One such in-source-area type facility is an incinerator. Early incinerators, as found in large apartment complexes, some commercial establishments, and some municipal plants were most often both poorly designed and operated. They frequently created and released into the atmosphere totally unacceptable levels of health endangering pollution. Dioxin emissions being the main point of controversy. Most conventional incinerators are unable to fully combust all the materials fed into them, especially when overloaded. (Telephone books and grapefruit hulls being examples of common uncombusted items.) Most incinerators leave a residue of ashes and non-combusted materials that have to be put into landfill.

Incinerators produce air pollution. Equipment to control the pollution (scrubbers or cyclones and electrostatic precipitators) has to be installed, operated, and maintained. In areas subject to significant levels of air pollution from other sources, added pollution from incineration may well be unacceptable. It is also a facility that is commonly viewed as being inappropriate to if locate close to residential areas. Experts argue that even modern incinerators may produce toxic and carcinogenic by-products from the burning of plastics. Incinerators are also thought to emit heavy metal compounds.

Energy from waste facilities combine the incineration process with an energy recovery process. Such facilities are much more common in Europe than in North America. They are varyingly located in industrial areas, commercial areas, and residential areas. For example, in Nord-West Stadt, West Germany, an on-site energy from waste plant is located at the centre of a modern neighbourhood to supply steam to 8000 apartment units, offices, and retail stores.

A recent report on the Environmental Health Effects of Waste Incineration in the City of Toronto (Board of Health, 1987) concluded that there was limited information available on the chemicals present in the gaseous emissions and ash, on the impact of such emissions on the ecosystem and on the health effects of long term low level exposure. The report further contends that the enforcement of rigorous standards of operation under the Environmental Assessment Act can reduce potential effects of incineration on health and environment. However, the Provincial Minister of the Environment has declared that incineration cannot be part of Metro's plans to limit the amount of waste destined for landfill.

Photo: Vince Pietropaolo

Compost

If successful programs of recycling metals, glass, plastics, and newspapers are implemented, then the remainder of the garbage can be largely composted. The remaining material, primarily food scraps and garden trimmings, can be treated to produce compost. Micro-organic breakdown of the bio-degradable material into powdery compost occurs if the material is turned and agitated to maintain an internally anaerobic condition. Once the process is complete, the compost can be added to garden soil. This improves the soil's fertility by improving the moisture retention capacity. However, in terms of the commonly held view that fertility is a function of nutrient availability, compost is a poor fertiliser, albeit one that is natural to the environment and one to be recommended.

Photo: Vince [illegible]

Suburban and urban gardeners traditionally construct "compost heaps" from grass cuttings, shrubbery trimmings, leaves, and vegetable food wastes. If the heap remains in an anaerobic state then little odour is released. If meat scraps are not added then the danger of rodent attraction is reduced. Newer, self contained, composting barrels are also being currently recommended as viable compost generators for urban areas. As a result of Metro Toronto's decision to ban leaf disposal in landfill, Metro is currently encouraging leaf composting by home owners, or special pick-up of bagged leaves for composting in Metro-run composting facilities. The Metro Works Department and the City of Toronto Department of Public Works conducted a trial lawn and garden waste composting project for selected homes within the areas of Rosedale and Forest Hill during the early fall of 1989.

Further, Metropolitan Toronto Council recently approved a pilot program to distribute composting bins within Metro. Toronto. The pilot project will help determine what role home composting should play in Toronto's long term solid waste management system and in attaining the desired goal of 25% reduction by 1992 and 50% reduction by 2000.

Hazardous Wastes

Historically, chemical wastes, including all categories of hazardous wastes, have been disposed of as expediently as possible. Wastes were burnt into the air, flushed into the water, or buried into the land. Today, apart from illegal midnight dumping, those direct discharges are behind us. However, making direct dumping illegal has not removed the problem of what should be done with such wastes. The legislation has not legislated them out of existence, but perhaps only out of view. Industrial preference and early legislation restricted the disposal of waste in water or air. Consequently, most waste was disposed of by burial in supposedly safe land sites. There are essentially three ways in which hazardous wastes are disposed of in land: deep well injection; surface impoundments; and landfills. Each of these may be relatively safe if perfectly constructed, operated, and maintained. However, the ideal is seldom found.

The method of disposal by deep well injection involves drilling into porous material (supposedly) below the level of deep groundwater. In theory, hazardous material soaks into the porous material beneath and remains isolated from the groundwater. As it is impossible to guarantee any rock is fracture free and will remain so under the added pressure exerted by the injected material, and as it is equally impossible to guarantee that the casing will not corrode, and the bottom seals will not fail – the method is one fraught with potential problems that are usually realized in practise.

The method of disposal involving surface impoundments is the cheapest way of disposing of large amounts of water carrying relatively small amounts of hazardous material. The waste is discharged into a lined pit. The water is permitted to evaporate while the hazardous chemicals settle out of suspension. This system may operate indefinitely provided the liner seal does not rupture. The danger from hazardous chemicals evaporating with the water is considered to be significant as many hazardous materials are volatile.

The method of disposing hazardous waste in landfills is the least common of the three throughout north America. Hazardous waste in concentrate form are put in drums and buried in landfills. If the landfill is properly lined, covered, and has a good leak and leachate collection system, it is presumed safe and is referred to as a secure landfill. In practice, the bottom clay-liner often leaks because of insufficient clay, or incidences of rupture in the plastic liner. The plastic liner deteriorates with time and may easily tear. Many consider landfills as accidents waiting to happen in as much as the contents will ultimately be bound to leak from the site.

The major problems of undertaking hazardous waste disposal are, first, ensuring that all the appropriate wastes actually get to a proper disposal facility, and second, ensuring that the disposal facilities are properly constructed, operated, and sealed. History reveals that much midnight dumping in old farms, old warehouses, or vacant lots has occurred. Equally, considerable quantities have been sneaked into sanitary landfills, or drained behind moving vehicles along country roads again at night presumably. More recent history reveals that the supposedly secure landfills of the Niagara area, and other areas, are not secure.

The major problem of improper hazardous waste disposal and management in land has been seen in the many cases of groundwater pollution, and the resultant harm to human and ecological health.

Further questions that relate to the issues of safety for human and ecological environments include the appropriateness and necessity of the production of such chemicals, by type and by amount; the recognition of the levels of applicable risk and uncertainty in all matters pertaining to hazardous wastes; the method and route of transportation; as well as the method, location, and the proposed length of time of storage and/or disposal, and the full evaluation of potential contamination and the time frame, future generation, that will be impacted.

Contaminated Soil (Polluted Ground)

Current usage of the term "contaminated soil" may confuse those who have used the term over the years in a different context. Today, "contaminated soil" is taken as being synonymous with "polluted ground". Confusion stems both from the original meaning of the phrase to agriculturalists and pedologists (soil scientists), and also from the meaning of the component words. To farmers, gardeners, environmental scientists, and most individuals, – "soil" is considered, (and most appropriately so), to be a living mixture of air, water, minerals and organic matter, in which pedological (soil forming) process operate such that the soil is always in balance with its environment and the living organisms it supports. To scientists, a "contaminant" is the presence, however minor, of any element that is not normally encountered in a particular environment. Nevertheless, a "contaminated soil" has come to be taken as any piece of ground, earth, or land, be it a "soil" or an accumulation of rubble and fill, that contains any contaminant at a sufficiently high concentration to be considered dangerous to human health. Provincial guidelines also suggest that the term extends to that ground which is to be considered harmful to the health of animals and vegetation, though this usage may not be altogether common. It is undoubtedly too late to recommend a return to the more appropriate meaning of the words involved, but it is perhaps preferable, as here, to regard "contaminated soil", as being synonymous with "polluted ground".

The pollution of ground may occur inadvertently as when oil or chemicals are spilt as a result of an accident, or if oil or chemicals leak slowly into the ground from current or forgotten industrial storage tanks or conveying pipes; it may occur intentionally as when hazardous wastes are disposed of by burial in excavations, or by injections of liquid wastes into shafts or boreholes; or it may be semi-intentional, or incidental, as when fertilisers and other chemicals are applied to the land. Pollution in the ground may be found in solid, liquid, or gas forms. However, it is most often put into the ground as a solid (this includes dust particles), or liquid concentrate that is subsequently dissolved, or diluted, and transported elsewhere – either as a liquid, or in suspension within a liquid. Clearly, groundwater can become very polluted and the pollutants may be transported both horizontally and vertically, in all directions. Such transport is rarely very swift. In consequence, the impacts of adverse pollution may not be realized, at locations distant from the polluting source, for considerable periods of time.

In Toronto, as in many other industrial cities, all the present and former sites of industrial activity and industrial waste storage or disposal, plus all the present and former lands that belong(ed) to the railways are the potential locations of polluted ground. These are mostly, but not exclusively, to be found, within Toronto, in areas to the south of Queen Street, and most notably at the locations of former landfill sites, such as those that were used to create much of the Toronto waterfront area to the south of Front Street. Similar problems are identified in present and recent areas of "lakefill" that receive(d) the excavated ground and rubble from development sites across the City. This is especially true of those lakefill areas that take fill from the old industrial and rail corridor lands. The particular pollutants that have been found within the excavated ground of Toronto and are a cause for alarm, include: toxic metals (such as lead, copper, arsenic, zinc, mercury, chromium, cadmium, and phosphorous), PCBs, PAHs (coal tar), and other organics. PCBs (PolyChlorine

Biphenyls) and PAHs (PolyAromatic Hydrocarbons) are considered carcinogenic. PAHs are most notably found at the former sites, and along the former pipe lines of the coal-gas liquification plant (Consumers Gas) that was located in Toronto.

The deliberate disposal of wastes in the ground, in such a way as to avoid accumulations of contaminants at levels considered to be "polluting" is often performed according to the "dilute and disperse" approach. Wastes are allowed to dissolve in or be diluted by groundwater and flushed away in concentrations that are hopefully harmless by the time they reach the sources of water supply.

The current concern with "polluted ground" or "contaminated soil" is with the past, present and future location of private and public dwellings or institutions on top of such ground. The issue is one of the appropriateness of ground pollution testing procedures and standards, the ensurance that the appropriate tests are indeed performed, and the manner in which the acquired information is utilised in arriving at appropriate land use planning decisions. To oversimplify: current testing and analysis procedures, as specified by the Ontario Ministry of the Environment, evaluate chemicals in isolation from each other and the environment in which they are found. No attempt is made to assess catalytic effects (where a particular chemical may accelerate or reinforce another chemical reaction in which it remains unchanged) or synergistic effects (where an effect is produced that is greater than the sum of the effects of each chemical acting alone), or ecotoxic effects (where long-term low-level exposure and bio-accumulation effects within the environment are considered). These limitations are said to be a function of the present lack of knowledge of such matters, and the great cost that would be involved if such testing were performed routinely.

Past decisions as to the appropriateness of a specific land use, (e.g. the construction of the St. Bruno School at Melita Crescent and Shaw Street, near Davenport Road, on the site of a former steel fabricating plant, which operated or maintained the land from 1915 until 1977 when the school was built) were based in part upon the then established guidelines and standards of the Provincial Government. Insisting that all development be subject to "contamination" testing, is a first step toward safety for all, but real safety will only be realized with more stringent guidelines and testing standards than are currently followed. It should be remembered that the St. Bruno site met all the required testing standards before it was constructed, and again when it was retested. (Further, it should be remembered that in the specific case of the St. Bruno site, the exact nature of the problem, as well as the cause of the problem, have yet to be identified and in fact may have nothing to do with contaminated soil).

The City of Toronto has been consulted by the Province in regards to updating and improving the Province's Guidelines for the Decommissioning of Former Industrial Sites. The City has noted that organic contaminants have not been sufficiently well addressed in the established guidelines to permit the City to perform a complete assessment of proposals to redevelop former industrial sites. The City hopes that this will be rectified by the Province in their new guidelines. Problems may remain with those lands on which industries "fade-away", rather than on lands which industries pronounce an end to their own activities. The City is also compiling, from City and Provincial historical records, a dataset of former industrial sites and the activities that took place. In consequence, it is most unlikely that any new construction would ever be permitted on land which can be clearly recognized as potentially polluted without appropriate evaluation and guarantees that it meets the new decommissioning guidelines. Questions will remain, however, as to the appropriateness of those guidelines, and fears will remain as to the number of problems that have been buried and forgotten, only to "surface" later.

Products Used On Land

Fertilizers: Certain urban-environment problems of today, specifically the use of fertilizer and pesticides in too copious a manner, have their roots in solutions proposed during the mid-forties for the agricultural problems of the Third World.

The "Green Revolution", based largely upon dwarf hybrids has not been the hoped for panacea for the world's agricultural and food supply problems. The traditional crops of wheat, rice and sorghum are large leafy plants. The large leaves help to restrict the light that is available to weeds. But the size of the leaves inhibits close planting. The simple application of fertilizer merely made for more leaves and caused more mutual shading, and hence weaker spindlier plants. In order to overcome such problems, new, high yielding, dwarf hybrids of wheat, rice, and sorghum were developed. This began in the 1940s. The new varieties have short stems, small leaves, and shallow roots. Without the plentiful supply of fertilizers, water, and various pesticides, the yield of these varieties is no better than the older traditional varieties.

The relevance of the above information may not be immediately apparent for urban situations such as exist within Toronto. However, the philosophy of hybridization and chemical control has been adopted not only by western farmers, but also by western urban gardeners and park managers. Unfortunately, the philosophy and practices of the Green Revolution have not always been adopted with a full comprehension for the accompanying environmental impacts.

The use of chemical fertilizers is a spiralling requirement. In order to make use of the nitrogen in fertilizer, for example, soil microbes have to consume organic matter (energy) from the soil. The depletion of organic matter leads to an increased demand for fertilizer. A cyclic dependency is created.

The application of environmentally excessive amounts of fertilizer has been a common part of farming practice since the early 1950s. This has led to such impacts as the eutrophication of lakes in or adjacent to agricultural areas. Eutrophication is the presence in a lake of an over abundance of nutrients, usually nitrates and phosphates, that causes algae blooms and a choking of the lake habitat. Similar consequences occur because of "chemical gardening" in more urban areas. "Chemical gardening" is routinely practised by many home gardeners, municipal parks departments, and golf course operators.

Chemicals are used to encourage the growth of all forms of plants, from grasses to trees, in urban areas. Applications of fertilizers to grassed areas probably presents the more significant environmental impact. The desire to achieve plush green lawns, and manicured grass areas, or golf (putting) greens, whatever the prevailing climate and weather conditions, can have very significant environmental impacts. Often, and as "bad" as environmental groups like to label farmers in this regard, farmers do respond to the financial disincentives that discourage too frequent and too concentrated applications. Urban gardeners, however, often appear to be less susceptible to such cost constraint. Chemical gardening involves the applications of fertilizers and various pesticides. Much of which finds its way via runoff or groundwater flows into nearby water bodies. As suggested above, many such chemicals are unhealthy for humans and for the environment.

The application of excessive amounts of water is rarely seen to be as environmentally damaging, but in fact it may be so. The perceived need for plush conditions on lawns and golf course greens often encourages excessive irrigation, which leads to compaction of the grass plants, and in turn leads to disease susceptibility, and hence leads to the need for increased herbicide applications. Over-watering not only consumes a valuable resource, but may lead to negative environmental impacts.

An alternative to excessive use of chemical fertilizer can be found in a program of balanced organic management. The use of organic fertilizer, the use of pest and disease resistant plant species, and the greater use of climate suitable plants, such as plants native to the region rather than exotics from elsewhere. Measures such as these would reduce gardeners' dependency upon chemical fertilizer; such measures are more fully discussed in many simple to understand pamphlets, such as *How to get your lawn and garden off drugs*, (Rubin, 1989).

Pesticides: One of the greatest environmental concerns of many people is the potential for adverse effects to human and environmental health from pesticide use. The now classic tale of the use of the insecticide DDT [Dichloro-Diphenyl-Trichloroethane] perhaps best illustrates the issue. Bioaccumulation through the food chain resulted in reproductive failure among fish eating birds such as the Osprey and the American Bald Eagle; eggs were breaking apart in the nest before hatching should have occurred due to calcium deficiencies. [DDT interferes with calcium metabolism.] In the years since the banning of DDT in the early 1970s there has been a marked recovery of those populations that were affected. Many pesticides are considered to be carcinogenic in humans. There is concern that residues of the pesticides remain on food that is consumed by people.

The term "pesticide treadmill" is used to describe attempts to eradicate pests with synthetic organic chemicals. The chemicals do not eradicate the pests. They encourage the survival of those strains that are resistant to the particular pesticide. Use of the chemicals effectively leads to increased resistance and secondary pest outbreaks. Pest populations become immune to the pesticide. The process is never ending. Stronger doses or new chemicals have to be employed. Unfortunately, such chemicals do not have to be fully evaluated before they may be used. The "D_{50}" tests measure how much of a single product is required to kill 50% of a test population of an indicator species (e.g. mice), but do nothing to gauge the synergistic effects, or the likelihood of catalytically generated secondary products being hazardous, or ecotoxicity effects of such chemicals released into the environment.

Perhaps of even greater concern is the practice of not banning chemically related chemicals when one is found to be dangerous. In this regard the Canadian government largely follows the regulations established in the U.S.A.. To return to the earlier example, DDT is just one of many chemically related, persistent, halogenated hydrocarbon pesticides. When the problems associated with DDT were revealed, prudence dictated banning the whole group (none had been tested at that time) because their chemical similarities made it very likely that they would all bioaccumulate and pose long-term human and wildlife health hazards. Yet, regulations preclude such guilt by association. Each chemical has to be individually tested. Even if such a chemical should fail the "D_{50}" test, the government must show that risks to humans are greater than the agricultural benefits derived from its use. Thus, it took many years to ban the DDT related pesticides: chlordane; aldrin; mirex; dieldrin; kepone; DBCP [DiBromaChloroPane]; and most recently, as in 1984, EDB [EthyleneDiBromide].

The answer proposed by some is to use non-persistent pesticides. These non-persistent pesticides are synthetic (often organophosphate based) and they break down in the environment into simple non-toxic products within a few days or weeks of application. This makes bioaccumulation in the higher levels of the food chain unlikely. But are they environmentally safe? There are several reasons why such non-persistent pesticides are not as sound as their proponents claim. Many are more toxic than DDT; they also require more frequent application, and are thus a danger to farmers or gardeners who apply them. Also such chemicals may have considerable inadvertent impacts. For example, spraying such a pesticide to control spruce bud-worm in New Brunswick resulted in the death of an estimated 12 million birds due to loss of their food supply of other insects. Many such insects, as for example bees, are desirable for pollination of a farmers crops or a gardeners flowers. Their loss is not desirable.

Salt: In various other parts of the world the "salt problem" is associated with land subsidence, plant tolerance, or soil salinization. But in Toronto the problem is one of salting the roads in winter and the impact this has upon the environment. Salt is used to "melt" ice, or to prevent water from freezing as ice, on road and path surfaces. It deliquesces. Salt operates in much the same way on road surfaces as it does in the oceans. It lowers the freezing point of the solution. Coupled with sand and grit it is applied liberally on the major roads of Toronto during snow and ice storm events.

Photo: Vince Pietropaolo

The problem is twofold. One, salt is very corrosive of metal structures, such as cars and bridges. Two, salt is very toxic for aquatic ecosystems, such as should be found in the Don, and in Lake Ontario.

The problem of salt causing a premature "rusting" of vehicles is well known in the Toronto area. Premature rusting shortens the life of vehicles and leads to a greater need for recycling because non-renewable mineral resources are consumed.

The problem of salt being injurious to aquatic ecosystems is probably less well known. However, road salt is deleterious to the life forms that inhabit freshwater bodies. Such salt gets into the natural water system of rivers and the lake either because it is carried in liquid solution via the storm sewers, or because it is collected in the street snow removal process, and subsequently dumped at storage sites near the lake. As the snow melts and runs into the adjacent lake or river, the dissolved salt is carried with it. The concentrated injection of salt at the time of the spring melt is its most harmful aspect. Later it may become assimilated, or flushed to the sea. However, as the salt concentration slowly increases in the Great Lakes – so the degree of impact upon aquatic species will become more severe.

It is possible for private individuals to purchase a Urea and sand grit based product which is preferable to salt in that it should not harm terrestrial vegetation, such as grass and plants that is adjacent to path or driveways, but as it is in essence a type of nitrogen based fertilizer, its widespread use may ultimately cause lake eutrophication impacts.

Use Of Land

The appropriate use of land within urban and rural environments has been central to the concept of "town planning" in Canada since its inception. In urban areas it has been most manifest in the practice of disassociating noxious land uses (commonly industrial ones) from residential and other public access land uses. This has been accomplished by zoning land for its most appropriate use, where "appropriateness" has been determined by the adjacency of similar and dissimilar land uses.

Today, the need to separate incompatible new land uses, such as industrial enterprises from residential neighbourhoods, is less significant because all new developments must comply with provincial regulations that are intended to ensure environmental health and safety. It is possible to operate new industrial plants in non-polluting ways such that they might safely be located in residential areas: were it not for other social and community related requirements. The problems of incompatibility today, however, are associated with the long established uses, the legally non-conforming polluters such as the rendering plants, and tanneries that are to be found within Toronto. Current land use decisions have also to be made in recognition of previously polluted land such as the former Consumer Gas coal tar (Poly Aromatic Hydrocarbons) sites of Toronto.

Decisions as to the appropriate use of land in urban areas must take into account all the questions, issues and concerns raised in earlier sections that dealt with air, water, and land quality and quantity. Such decisions, however, must also include consideration of the visual aesthetics in such things as: the location or expansion of transportation corridors for rail, road, bicycles, or pedestrian traffic; the nature and dimensions of hydro-transmission lines and other pipeline corridors; the location and outside face of commercial, retail, and manufacturing enterprises; the massing of buildings along thoroughfares, or adjacent to open space; and the visual compatibility of the scale and design of all new developments with the pre-existing community.

Other use of urban land considerations include the noise, vibration, and smell that can be anticipated to accompany the land use. Noise and vibration is of most concern when questions of road, rail, or airport traffic is involved; however, it is often a cause for concern when new industry, or new industrial processes are proposed. Noxious odours (objectionable "smells") is most often the consequence of old established industrial plant operations; land use decisions concerning adjacent uses have to be made with this in mind. This may lead to such apparent reversals of logic as placing restrictions on residential development because of the legally permitted pollution from an adjacent non-residential source.

Environmental Consequences of Urban Sprawl

The expansion, or sprawl, of urban centres across prime agricultural land has been recognized as undesirable for many years and as a central component of regional land use planning. Sprawl is linked to patterns of transportation. In essence, the large metropolitan cities of North America have come to exhibit low density residential origin zones (sprawling suburban subdivision and sub-centre dormitory communities), and high density employment and "downtown" activity destination zones, (central business districts and downtown theatre-retail-restaurant districts). Historically, the low density zone expands ever outwards over abandoned farmland, and the high density zone becomes more massive, taller, and is often also seen to encroach on adjacent inner-city neighbourhoods. Both of these circumstances, low density dispersal and high density concentration, are environmentally undesirable as is discussed below.

Suburban development is not new. In the specific context of Toronto, just as Metropolitan Toronto has come to be encircled in the 1990s by external "suburban developments", so it was in the early 1950s when the City of Toronto was encircled by the "suburban developments" of what is now Metro. Going back further in time, each of the major east-west streets (Eglinton, St. Clair, Bloor, Dundas, Queen, etc.) marked the northern limit of the "civilized city", beyond which lay open farmland. The suburban developments of bygone eras have become the central inner city neighbourhoods of today. Each successive semi-concentric ring of development was coupled with an expansion of the means of moving people from their origin to their destination, as from their homes to the downtown district. In the period since 1945, the explosive population growth and trend toward greater urbanization has been clearly coupled with regional economic growth, greater personal material wealth, and the greater reliance on the automobile as an "economic good" (one to be produced and purchased), and as the means of making the journey to work possible

Photo: Vince Pietropaolo

without having to migrate closer to the workplace, or to live in a more expensive urban environment.

Urban sprawl may occur as a deliberate complement of a planned expansion of a public transit system. However, more commonly, urban sprawl has occurred by default. Some suggest that the urban sprawl in the Los Angeles area originated because of the finger like expansion of the rail service, the interstices of which later became infilled with suburban subdivision development that lacked any significant provision of public transit. Residents came to seek solution in complete-trip travel, and demanded extensive highway development. This might have been foreseen and more consciously accepted or avoided.

The major component in the North American concept of urban sprawl has been the development of transportation systems that are largely based on the automobile. Indeed without the automobile, urban sprawl as it is now to be seen, might not have been possible. Even the provision of railway, or subway, based commuter transit services has led to further sprawl in that the automobile, to borrow a term from the cattle industry, tends to feed the railway and "railhead" points. Urban growth also occurs along the roads that link urban centres, as such the very presence of highways has led to ribbon expansion along urban fingers. Sub-division developments later infill the interstices between the fingers of growth. Cities come to grow laterally in this manner, but not in as clear an encircling pattern as the case of simple sprawl until greater time periods are passed.

Once established, the urban transportation and land use pattern associated with sprawl is very difficult to reverse. Therefore, the present reliance that society places on the automobile also enforces a future reliance that will be difficult to escape from. Though an obvious truism, it is worth noting that different people have different life styles, personal visions and aspirations for the good life. To what extent people choose to live in the automobile orientated suburbs because they want to, and to what extent they live there because they are economically forced to do so is a mute point and need not be debated. It is sufficient to recognize that people have differing points of view and to encourage dialogue and understanding between them. Regional planning and policy, ranging from the utilitarian to the Utopian, ought also to be commensurate, even complementary, with this reality.

Photo: Vince Pietrapaolo

The automobile symbolizes many things to many people, but it has come to be seen, by some, as a necessity of life that permits social and business interaction in and adjacent to their low density residential areas, and by others, as a curse of downtown living that is imposed by those who commute to the downtown area of city residents, or by fellow inner city residents who are oblivious to the aesthetic and environmental degradation caused by the automobile. Clearly, the automobile generates pollution (see page 20) and to oversimplify, the greater the number of automobiles that travel into the city, the greater the pollution that is generated in both the regional and city context.

Environmental considerations should not, however, be limited to the topics of the consumption of (farm) land and the impact of the automobile. Other notable concerns relate to the consumption of energy, the consumption and pollution of water, the disposal of urban waste and the release of pollution into the atmosphere.

These considerations should be considered in the light of all the various patterns of urban growth. However, the range of patterns is here simplified to that of suburban dispersal and urban concentration. As stated above, both of these patterns of growth are environmentally undesirable. Patterns with similar environmental impacts are touched upon in the context of the pattern they most resemble. The preferred alternate is presented toward the end of the discussion.

The pattern of suburban dispersal leads to concern for many environmental issues. The consumption of former farmland and the urban shadow cast on farmland beyond the rural urban fringe is an obvious concern. Related social questions such as farmers wishing to sell their farms to provide for their retirement, and questions of farmland being converted through the pressures of speculative development into zones of abandoned or degraded farmland in advance of development (into a "horseyculture" zone where urban population dependent recreational land uses such as golf courses and riding stables often become temporarily established, see Mather, 1986, p.134) are not addressed here. Environmental issues relating to urban sprawl include concern for: the greater use of water as used to irrigate lush green lawns; the greater use of the products of chemical gardening and the greater ensuing pollution of water courses; the greater consumption of energy in less efficient (by type and size) single house heating, ventilation, and air conditioning (HVAC) systems; the greater consumption of petroleum to fuel the greater automobile use; the greater production of automobile generated air pollution (or as produced by whatever form of motorized transportation is adopted); the greater consumption of financial resources to provide for ever lengthening storm and sanitary sewers; and the greater consumption of electricity because of the greater distances involved in its delivery. Every cloud has a silver lining and urban dispersal does, however, have some environment related benefits. Dispersal does permit for adequate provision of quality open space and recreation areas within the residential communities, though it is doubtful if there is any less of a pressure exerted on natural areas and environmentally sensitive areas.

A similar set of impacts can be contemplated for the pattern of "finger sprawl", especially after the interstices have become infilled, however, prior to the infilling actually occurring, the reliance on the auto is commonly reduced as people use their vehicles only to reach the provided transportation nodes. This can be considered to be preferable, in the short term especially, by the inner city recipients of train-using commuters rather than the automobile-using commuters. Urban land consumption would initially be less in real terms but the amount taken out of agricultural would be little altered as the abandoned farmland activities (riding stables, golf courses, etc.) quickly come to occupy the space between the fingers, and the urban shadow extends even further. Following the inter-finger infill, the recreational use of abandoned farmland would again be forced to spread into the new rural-urban fringe, and the shadow would extend further beyond it.

The pattern of dispersed centres, or nodal new towns, as found beyond the present rural-urban fringe may have environmental benefits if the dispersed centres are truly self contained and provide residential and employment opportunities, and are also linked together by a transportation system that is independent of the pre-existing hub. Most new towns have developed as dormitory suburbs, however, and the potential environmental benefits (less automobile use, less land consumed) are not realized. The costs of infrastructure provision (roads, and sewers) is normally much greater. The potential for ribbon development between the dispersed centres and the eventual infill of the interstitial space is high and rarely untouched.

The environmental significance of concentration, especially high density concentration, has many advantages and disadvantages. On the good side: automobile use is lower relative to the other patterns of urban sprawl, and energy consumption and air pollution is likewise reduced. The need for an expansion of the infrastructure of water supply and sewers (as required under the sprawl scenario) is replaced by the "overdue" (relative to the sprawl) upgrading and servicing of existing water mains and sewers, in consequence less water should be lost through leakage and other inefficiencies. Multi-family units are also potentially more efficient in their HVAC requirements. However, this factor is perhaps rarely realized due to the lack of HVAC building inspection, operator training, and the practice of "setting" temperature and humidity to satisfy the loudest complainers rather than at appropriate levels. On the bad side: greater amounts of energy are needed to operate the electric powered elevators of high rise buildings; greater amounts of energy are needed to raise water (as used in toilets, showers, kitchens etc.) to the upper levels of high rise buildings; less flexibility is available to add rooms or plant a garden; less provision is traditionally available in established buildings for the appropriate reduction and sorting of wastes (garbage etc.); and any pollution that is emitted is potentially more likely to be concentrated within a smaller area and most often within urban canyons. This last statement does not contradict the universal truism that "dilution is not the solution to pollution" but does suggest that local concentrations may be harmful to the health of humans or natural environments. The quality of available open space for active or passive recreational pursuits and the preservation of natural areas is reduced. Here again it should be remembered that the only opportunity that public bodies normally have of acquiring public open space is when an area of land is being developed. In a sense "something is always better than nothing" but open space in central concentrated areas of high density rarely lead to the creation of quality open space. As concentration densities increase the open space is often squeezed into other districts altogether. Most frequently such open space as is provided is overshadowed by the urban forms that surround it, usually forms that exhibit extra height or mass because of the open space allowance provision connected to the development.

The preferred pattern of urban development from the perspective of the protection and enhancement of the built and natural environment will most certainly be varyingly specified by different people. The concept of dispersed nodal sub centres far beyond the present bounds of Metro Toronto will appeal to some. Others may be disillusioned by the failure of the nodal sub-centre concept that was planned in the 1970s. However, within the City of Toronto, the preferred choice is fairly clear. Concentration within the City rather than sprawl beyond Metro should be supported. But that concentration should be of medium density, with low level, five or six floor "walk-ups" that have restricted use elevators, in mixed use developments that combine residential and commercial land uses. The City's "Main Streets" initiative is an example of trying to bring about precisely this type of change within the City.

Currently, these questions are being addressed and assessed by staff of the Greater Toronto Co-ordinating Committee (GTCC), Metropolitan Toronto, and the City of Toronto.

Recreational Land and Open Space

Land designated for recreational activity within urban areas normally includes: extensive areas of land designed to be used in an active manner, as with baseball diamonds, soccer fields, and so forth; as well as lands designed to be more passively used, as for walking and sitting. The latter are most often smaller in area, or more linear in form, than the land used for the more active uses. There is also a clear requirement, especially within Toronto's downtown core's central business district, for open space that permits (and encourages) a diverse range of functions, from providing appropriate gathering places, to providing people a place to sit and eat a bag-lunch. Obviously, there is a need for many forms of viable open space within an urban environment such as Toronto's.

The environmental concerns with urban open space and recreation revolves around a limited set of issues: the preservation of natural areas, the type and quantity of access to such areas, and potentially the non-provision of active recreation facilities within such areas; the provision and maintenance of people-use-suitable open space that is locationally and aesthetically appropriate and has acceptable conditions of light (sun-shade by time considerations), wind (strength, gustiness, pollution flushing, and dust carrying considerations), and noise (shelter from excessive noise considerations); and the degree of chemical gardening (see Fertilizer and Pesticides sections, above) employed in urban park and garden areas.

Photo: Vince Pietropaolo

In the absence of a universally acceptable typology of open space, three types of open space are referred to in this section: "green", "grey", and "green-grey". Reference to "green" space implies large parks, such as Hyde Park, and the Ravines of Toronto, as well as the smaller urban garden parks (or "parkettes" in 1960s terminology). Reference to "grey space" implies the gamut from squares, and plazas, to supervised playgrounds (playlots or totlots). "Green space" is taken to permit the spectrum of active to passive recreation uses. "Grey space" is taken to permit everything from space for active gathering places for city functions, to the more passive requirements of the lunch-bag crowd. The reference to "green-grey space" represents an attempt to recognize the complexity of the middle ground of combined resource spaces and function areas that exists within Toronto and other major cities of the world.

Recreation professionals have traditionally experienced problems within municipal governments of North America because of the usual combination of park and recreation responsibilities. (Elsewhere in the world it is more common for Public Works departments to be given the responsibility to maintain public municipal parks.) In North America, early municipal park departments were usually staffed by engineers or horticulturists who had little interest in providing organised recreation programs. Subsequently, the interest of recreation professionals, who attempt to promote physical fitness and provide sports or arts and craft programs, has seemingly achieved considerable harmony with the park horticulturists and engineers. However, the views of the environmental preservationists have not usually been as well incorporated. In Toronto, protectionist concern for the ravines and the waterfront has been recognized and acted upon, for a number of years, by both the Planning and Development Department and Parks and Recreation Department of the City of Toronto. The latter has also initiated a program of ravine management. However, to include natural areas (see earlier section), manicured gardens, and baseball diamonds, as areas that all have to be managed within the same organization leads to an obvious competition for land that is often difficult to resolve equitably or to everyone's satisfaction. The ravines of Toronto, and certain portions of the waterfront, are areas that are considered to be worth preserving in as natural a state as possible. However, they are also designated as elements of the City's park system. Thus, the more active use of such areas is not prohibited.

The question of natural areas, such as the ravines of Toronto, being an important part of the natural environment has been dealt with in an earlier section. However, and to state the obvious, it should be remembered that the demand for additional active-recreational green space is very valid and one that has significant ramifications for the maintenance of a "high" quality of life for the city's inhabitants. As such, conflicting demands for open space use have to be appropriately evaluated. Within Toronto, the amount of land available for recreation is limited. Competition for such land clearly exists, and will continue to exist between: manicured areas, and more active park uses; and natural areas, and more passive garden uses. These problems are dealt with in Toronto by the Parks and Recreation Department. However, the common request for "more green space" must be recognised as an ambiguity unless clarification is clearly provided.

A further area of concern, and potential conflict, is the adequacy of the provision of "grey" open space within Toronto. Essentially, such space has to satisfy a diverse range of functions. This is perhaps most noticeable in the downtown central business and commercial district where provision of many open space types from

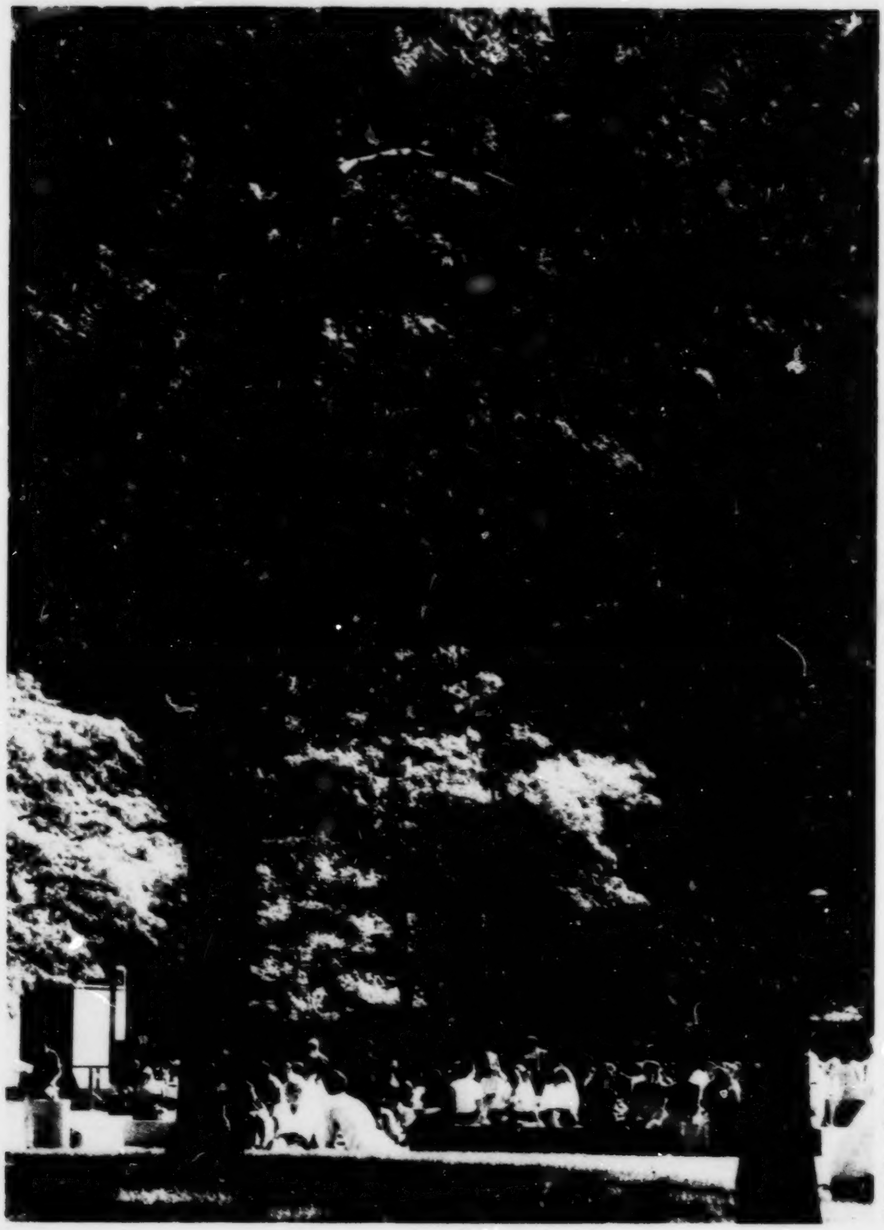


Photo: Vince Pietropaolo

appropriate large gathering places, to adequate places for people to sit and eat a bag-lunch are required and all the whilst maintaining appropriate visual aesthetics. In Toronto the present distribution of public open space in the Central Area is considered to be inadequate. The presence of certain private-but-public-accessible open space is a very important addition to the open space system of the city, but there can be no guarantee of its availability in perpetuity. Any consideration of public acquisition of additional open space land should, of course, be performed with due consideration for all the available open space, both the public and private-but-public accessible components of the open space system, within the city. Purchase of such land should preferably also be undertaken with consideration for the prevailing environmental and micro-climate conditions. However, it would be false to assume that "availability" and "economics" do not have a more significant role to play. That being the case it is appropriate to ensure that the present, and future, open space of Toronto be used in a manner that is consistent with the winter and summer seasonality of the city's outdoor environment. This requires that sun-shade, wind, and noise issues be considered in assessing any new proposed development that is adjacent to present open spaces, or includes open space, or is totally devoted to open space provision.

Architects have traditionally considered solar angles and radiation as part of the problem set of building design. This reflects their concern for heating and lighting problems. Considerable debate occurs among building architects in matters of preferred window size, building orientation, roof pitch, exterior skin materials, and whether or not to adopt active-solar technology. Similar debate occurs among landscape architects as to the preferred choice and location for specific city tolerant vegetation species, benches and ledges for people to sit upon, visual focal points, and the times of available (not blocked by buildings) direct sunshine. The form and massing of adjacent buildings, and the amount and timeliness of any solar interception (i.e., shade causing obstructions) obviously impacts upon the environment of the open spaces between the buildings. The shadow cast by the Sheraton Centre Hotel upon the western portion of Nathan Phillips Square during the lunch-hour period, is a case in point. It is perhaps an obvious example of a permitted adverse impact, but one that should now be deemed inadvisable from a purely "open space quality" standpoint.

The influence of wind upon building design has had a more obvious past than present. Architects of buildings in many parts of the world have varyingly avoided placing doors and windows on a cold-and-windy side (as in the Rhone Valley, France), or taken advantage of cooling breezes (as in several tropical locations). Today, wind is of concern for reasons of topological influence, that is the juxtapositional effects of buildings such that they generate and direct unacceptable strong winds on pedestrian areas and other open spaces, and the pollution trapping or re-

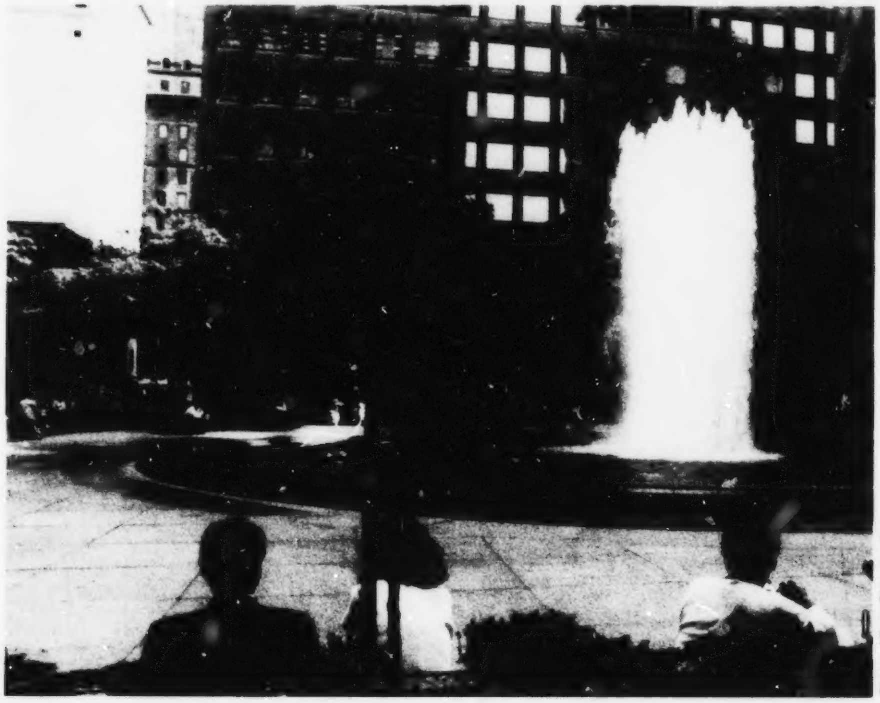
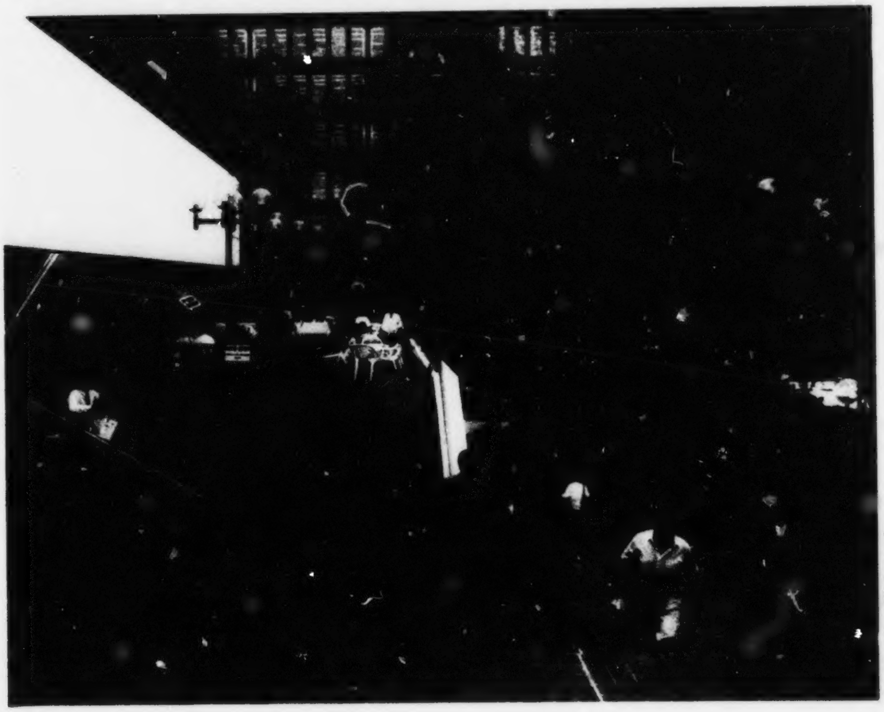


Photo: Vince Pietropaolo

directing nature of building spacing and orientation. Buildings in close proximity cause light winds to slow down and strong winds to speed up. Certain buildings can be seen to cause winds to make certain open spaces inviable under prevalent or dominant conditions. For example, the aerial water jet fountains frequently blow across the surrounding pedestrian pathways to such an extent that they become unusable by pedestrians. Slow wind movements, as found in cold air or frost drainage, make the use of enclosed sunken "green space" ill advised in the Canadian climate. However, they may prove worthwhile for "grey space" if concern for separating the space from the street and other access points, and concern for the safety and security of users can be addressed by other means. Such space may also have a beneficial "noise-reduced" value.

The questions of sun-shade, wind, and noise have been explored above in an earlier section under the heading "Air Quality, Regional Issues (Urban), microclimate", with respect to the good planning of buildings. The concerns that these factors pose to the good planning of open spaces is equally significant, and in reality the questions cannot and should not be separated. The presentation of the factors under the headings of "air quality" and "land use" reflects the interdisciplinary nature and the required interdisciplinary assessment of the concern.



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4

Sustainable Development

"Sustainable development" is a concept that has been proposed as a fundamental principle of decision making for all people in all walks of life in all parts of the world. Unfortunately, the concept is interpreted in different ways by different people, and in consequence, the term has come to encompass a great deal and to be difficult to clarify succinctly.

A common method of describing that which is difficult to explain is to define it. Sustainable development has not lacked for such interpretative definitions, indeed a plethora of them exist. Each definition, however, seemingly does more to clarify the originator's political viewpoint than the range of subtle distinctions that the term can engender.

Currently the spectrum of interpretations, ranges from a more economically orientated viewpoint to a more environmentally orientated viewpoint. Most often, sustainable development is identified with rural rather than urban areas, and with developing countries rather than developed countries. The following attempts to portray both the consensus definition and the range of variations that encompass it, for a western industrialized city environment.

The phrase "sustainable development" is often oversimplified and trivialised as ... environmentally sustainable economic development. The interpretation is perhaps neither accurate nor adequate. But it has acceptability because it stems from an interpretation that found public and political favour with the publication of *Our Common Future*, the report of the United Nations *World Commission on Environment and Development* (WCED, 1987), commonly known as the "Brundtland Commission Report".

The commission recognized that "Interpretations (of sustainable development) will vary." (WCED, p. 49, 1987). Some would suggest that this was the deliberate diplomatic ambiguity required to gain its widespread adoptance. The ambiguity is arguably both a strength and a weakness. It is a strength because it permits for a common acceptance among people and nations of otherwise diverse viewpoint. It is a weakness because it permits the adoptance of a popularist concept as a way of concealing retrenchment.

According to the most frequently quoted, by way of implied definition, extract from the report: "Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs. It contains within it two key concepts:

- the concept of "needs", in particular the essential needs of the world's poor, to which overriding priority should be given; and
- the idea of limitations imposed by the state of technology and social organization on the environment's ability to meet present and future needs." (WCED, p.43, 1987).

As such the concept of sustainable development is very closely linked to social equity issues, and to women's issues. The Commission's focus on the World's rural problems and the Third World's urban problems, rather than the situation in western industrial cities, makes the interpretation of "sustainable development" within western cities, of tentative value, at best, for many people. It is also considered by some, to be a questionable focus for urban planning and development.

However, it is within the western forum that certain environmentalists first began the promotion of urban orientated "sustainable development". The ideal of citizens being able to satisfy all their own needs, and being able to recycle, as opposed to dispose, all their own wastes, within the city, was promoted in the late 1970s and early 1980s, by such people as Todd and Tukel (1981). Their concepts included the technologies of: on-street solar sewage farms; warehouses converted to solar powered farm systems, whereby the activity on the upper floors generated the outputs of mass and energy required on lower levels; and on-street orchards, fish farms, et cetera.

Currently, the problem of definition and interpretation of "sustainable development" does not deal centrally with such holistic and idealistic urbanity, but rather revolves around the sense of approval required for individual developments. Three distinct interpretations of approval of sustainability are prevalent.

Sustainability is varyingly considered to be achieved in a development,

- if it replaces any damaged environmental elements,
- if it is environmentally compatible, or
- if it is environmentally self sufficient.

All of these are ill-defined. The first and third are also, seemingly, incompatible. Further, the middle interpretation is, perhaps, little more than a fuzzy spectrum of opinion that waivers between the other two mercurial extremes.

Viewpoints of sustainable development vary, and overlap, within and between, groups of environmentalists, planners, industrialists, and others.

The environmental/ecological view is the hardest of the three views to typify. However, their view of sustainable development tends to go beyond general statement toward the identification of principles related to specific issues. Typically they would consider activities to be sustainable when they: use materials in continuing cycles; use continuously reliable sources of energy; and come mainly from the potentials of being human, that is inclusive of communication, creativity, co-ordination, appreciation, and spiritual and intellectual development. They would consider activities to be non-sustainable when they: require continual inputs of non-renewable resources; use renewable resources faster than their rate of renewal; cause cumulative degradation of the environment; require resources in quantities that could never be available for all people; and lead to the extinction of other life forms, (after Nickerson's, Guideposts for a Sustainable Future Project, see Rees, 1989).

The view of business is also very diverse, but may be seen as generally close to earlier conservation strategies, those of the early conservation movements of 1910-1920 and 1930-1940, and the later perceptions of "Limits to Growth" (Meadows et al 1965). It is, however, almost an universal view of business people that "sustainable development" implies ... "environmentally sustainable economic development", in the sense of the first, or middle interpretation of "sustainable", as outlined above. Hopefully, it is only their detractors who ascribe to them a belief in ... "economically sustainable environmental development".

Just as the concept of "sustainable development" is rapidly being embraced by many business people, other business people prefer to regard conservation and environmental concern as synonymous with "plant shut down". Further, many environmentalists now prefer not to declare support for "sustainable development" because of its adoptance and redefinition by business as a perceived cover for retrenchment.

The planner, as ever, will have to be careful to tread a middle path. One such perspective is provided by the North American planner, W.E. Rees, who suggests that ...."Sustainable development is positive socio-economic change that does not undermine the ecological and social systems upon which communities and society are dependent. Its successful implementation requires integrated policy, planning, and social learning processes; its political viability depends on the full support of the people it affects through their governments, their social institutions, and their private activities." (Rees, p.3, 1989).

Photo: Vince Pietropaolo

5

The Environment and the Role of Environmental Planning

Environmental Planning

There is a divergence of viewpoint among both those who call themselves environmental planners and among those who see it from a distance, as to the nature and role of environmental planning. The spectrum of views encompasses expressions of environmental planning as "landscaping or "landscape planning" at one extreme to "ecological planning" and "environmental management" at the other.

Among self-styled environmental planners the divergence is less pronounced though not altogether absent. Here, as commonly within the environmental planning community, environmental planning is taken to mean preparing for purposeful action that is directed towards specific environments or environmental resources for the overall purpose of optimal enhancement of environmental capacity and quality. As broad as is this attempted definition, the listing of content is even more broad. Many specialists in such disciplines as biology, engineering, forestry, geography, geology, hydrology, landscape architecture, and regional planning have taken up the challenge of applying their knowledge to the avoidance or solution of environmental problems. Commonly such statements as that of Ortolano (1984) are widely accepted and frequently repeated, as below.

"Environmental planning is a field made up of contributions from several academic disciplines including biology, engineering, geography, geology, and landscape architecture among others. The contents of courses in environmental planning typically reflect the professional biases of individual instructors. When such courses are taught by landscape architects they have one orientation, and when they are taught by ecologists (or engineers or geographers) they have rather different orientations. Because it emerged as a field only in the 1970s ambiguity in what constitutes environmental planning is to be expected.", (Ortolano, p.vii, 1984).

In part, the response to the environmental crisis of the 1960s and 1970s, as seen in the curriculum of many universities, was to foster several new "environmental" fields, while many established fields, such as civil engineering and chemistry, developed "environmental" subfields. Taken as a whole, the resultant environmental fields fall roughly under three main headings: environmental science, environmental engineering and technology, and environmental planning.

Thus, "environmental planning" has become an ambiguous "catch all" sort of title applied to planning and management activities in which environmental (as opposed to social, cultural, or political, for example) factors are central considerations. It is often confused with environmentalism and with the preparation of environmental impact studies, but in reality, environmental planning covers an enormous variety of topics, ranging, for instance, from health issues in work places to global population and food supply problems.

In essence, environmental planning exists as a subset of planning. Planning may be viewed as the systematic process by which principles, goals, objectives, and strategies of implementation are sought and applied. Wherein data are gathered and analyzed, proposals and alternative proposals are considered and compared, resources are measured, priorities are established and recommendations are made for the deployment of resources designed to implement the established principles. (after LRPD, p.2, 1970)

As such, planning has both a private and public connotation. In the private sense it implies organized preparation for purposeful action. It is a basic everyday activity, a way of thinking and getting ready to act. The private sense of planning is also a component of public planning. Both private and public planning involves analyzing a situation, working out what is desired, exploring and evaluating options, and devising a course of action. However, at the more complex scale of public planning, various interests may initiate actions that are of themselves affected by other actions; and such planning, therefore, necessarily involves conflict and compromise. (after Lang and Armour, 1983).

Environmental planning can be viewed as either bringing a particular set of concerns to these kinds of planning or as a form of planning which addresses relationships among activities, environments and effects. Some environmental planners work for agencies whose mandate is defined around certain environments, be it a particular habitat, a watershed, the Great Lakes, a neighbourhood, or particular valley area. Other environmental planners are primarily orientated to certain activities, such as transportation or the pollution that emanates from one particular type of source or as found within one particular medium (air, land or water). Normally environmental planners, such as those involved by activity, attempt to increase the degree of environmental consideration to be incorporated in decisions affecting the environments of their specific concern. Still other environmental planners find themselves interested primarily in suggesting means to prevent, minimize, or mitigate adverse effects of activities on either general or specific environments.

Environmental Planning in Urban Areas

Environmental planning and management in urban areas is not a well established field. However, its challenge and its significance is potentially greater than that found within rural or wilderness areas. Urban environmental planning is concerned with the protection and conservation of all the elements of the natural environment that are viewed as critical components of our urban fabric, as well as with the protection of life and property from the hazards caused by the City's natural and artificially-made environments. Urban environmental planning addresses both relatively new topics associated with development and land use, such as toxic waste disposal and urban microclimate, as well as traditional ones, such as watershed management and site planning. (after Marsh, 1983). The contents of the present document perhaps suggests as well as anything, the breadth of concern to be found within urban environmental planning.

Urban environmental planners may have trained within any one of several academic backgrounds; frequently such training is within a particular branch of environmental science, or within planning itself, rather than specifically within environmental planning. Others may be trained in environmental engineering or public health fields. All tend to share a common concern for matters "environmental", but given the breadth of environmental science, environmental engineering and technology, and environmental planning issues and concerns – they frequently focus their own concern in very dissimilar directions even as it relates to the same issue. Such diverse environmental practitioners also lack a common language or conceptual framework. As expressed by Lang and Armour ....

> *"Complicating things is the involvement of a variety of disciplines, each with its own paradigm – that body of beliefs, values, ideas and theories which practitioners of a discipline accept and profess, and which guides their selection and definition of problems, their explanations of phenomena, their method of attack and generally their views of the world. Paradigms operating in the environmental planning field have various points of agreement and conflict. Because a paradigm is often difficult for its adherents to "see", however, the real sources of such conflicts are seldom articulated. Hidden agendas result, inhibiting interdisciplinary work and retarding development of the field. Further confusion is aided by the proliferation of public and private interests, responsible for and affected by environmentally orientated actions, which may bring a variety of perceptions to environmental problems. Public and political pressure for corrective and preventative action is equally variable."*
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> (Lang & Armour, p.iii, 1980)

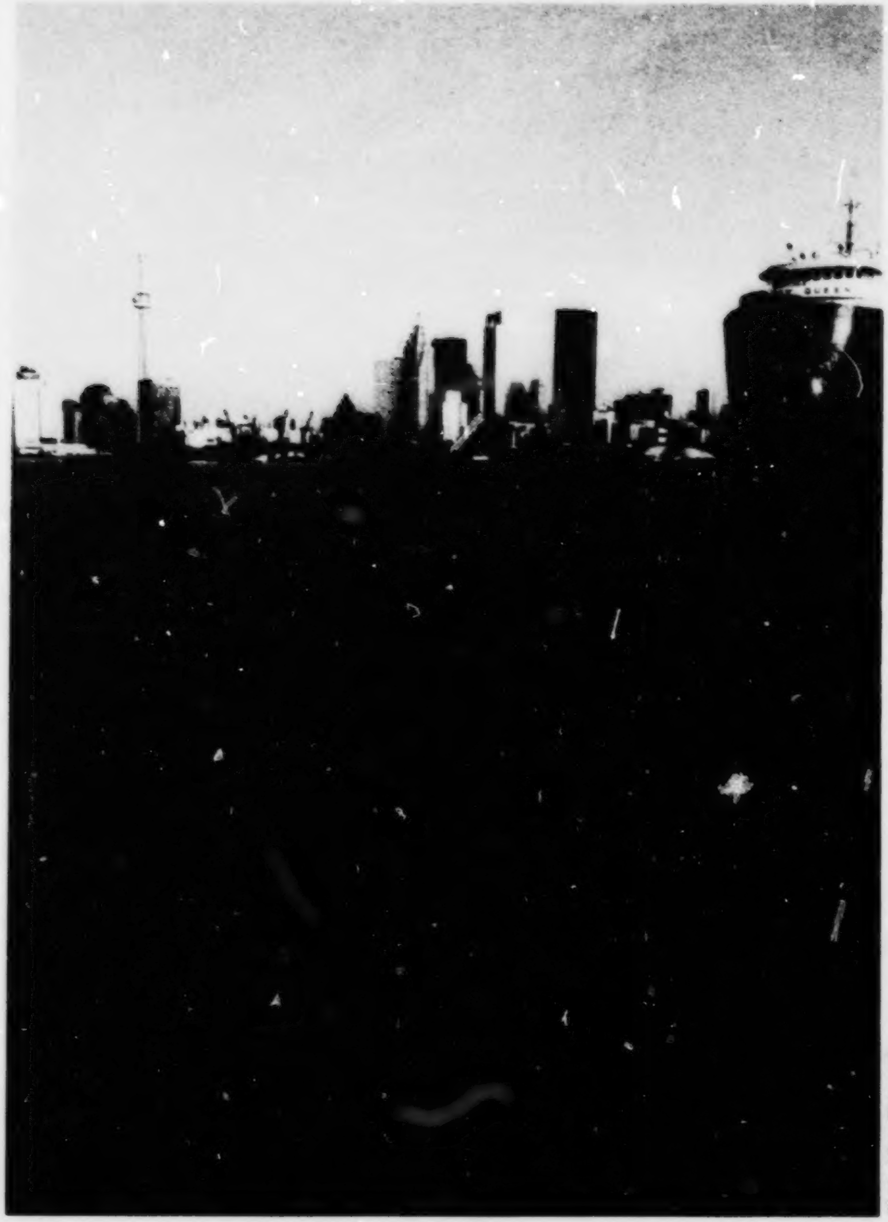

Photo: Vince Pietropaolo

Where urban environmental planning can be seen as a subset of planning and where planning can be seen as a process with considerable public and neighbourhood involvement, urban environmental planning is frequently involved with environmentalists and environmentalism. The present meaning of "environmentalist" emerged in the 1960s and 1970s, as a person who believes in or works for the protection and preservation of the environment. The environmental movement of the 1960s and 1970s took the form of a political movement to protect the "environment" from the onslaught of industry, government, and urbanization. Consequently, "environmentalism", is a philosophy, a political or social ideology, that implies nothing in particular about one's training, knowledge, or professional credentials in matters of the environment. The title of "environmentalist" has also come to imply anyone with concern for, or a job within, the "environmental field", rather than a specification of qualifications, or philosophy.

Municipal Authority

Municipalities are a specialized form of corporation that is created by a Province. Municipalities have no legal jurisdiction, power, or responsibility beyond that given to it by the Province. Certain municipalities, however, succeed in flexing considerable power, adopting considerable responsibility, and assuming considerable jurisdictional control. Toronto can be viewed as an example of this type of municipality. The only municipal law that is readily recognizable and that relates to matters of the environment, is that which is passed as by-laws of a municipality. Such by-laws are created under the authority of several Provincial Acts, including in the case of Ontario: the Planning Act; the Municipal Act; the Public Transportation and Highway Improvement Act; the Woodlands Improvement Act; the Trees Act; the Forestry Act; and, with specific reference to Toronto, the City of Toronto Act.

Traditionally, municipalities have been given the responsibility to collect garbage, to provide potable water, to dispose of sewage, to regulate noise, to regulate air pollution, and to plan land use within the municipality. Many municipalities have not fulfilled these responsibilities very well. The Province of Ontario, began in the 1970s, through the Ministry of the Environment, to assume certain of these responsibilities. For most municipalities this led to an improvement of the public good *vis-a-vis* their environment.

The source of most municipal powers to oversee matters of environmental concern is the Planning Act and the Municipal Act. Municipalities may pass by-laws regulating the use of land under the Planning Act. By this means a municipality, such as Toronto, is able to regulate zoning and the development, redevelopment, construction, repair, and demolition of buildings. With these powers a municipality may disallow such things as development in wetlands (e.g., marshes), or the construction of buildings that are intended to be used for industrial purposes that involve hazardous practices or materials.

The Municipal Act permits a municipality to enact by-laws "as may be deemed expedient (for the) health, safety, morality, and welfare of the inhabitants of the municipality". By-laws passed under these specific headings might cover: the supply of water; the operation of sewage works; street cleaning; aircraft landing at airports; drainage control and flood regulations; regulation of harbours, wharves, highways, sidewalks, bridges and fences, keeping of animals, storage of explosives, fire safety matters, inspection of food and restaurant premises, and the acquisition of parks or other open space (after Estrin and Swaigen, 1974, and 1978).

In the specific context of Toronto, a number of by-laws that have environmental intent or impact have been passed pursuant to various enabling legislation. By-laws regarding smoke abatement, incinerators, street cleaning, sewage service rate, destruction of Tussock Moths, and the "poop and scoop" issue, and the prohibition and regulation of CFC's (chlorofluorocarbons and halons) have all been passed by Toronto City Council pursuant to the Municipal Act. Other environmental by-laws, such as those respecting smoking in the workplace, noise, littering, and the imposition of special charges in respect of buildings (e.g., high rise buildings) placing heavy load on the sewer system have all been enacted pursuant to the City of Toronto Act. A further by-law, respecting the control and eradication of Dutch Elm disease was enacted pursuant to the Plant Diseases Act.

As a final comment, it has to be remembered that whatever by-laws are approved, or considered, must conform to all other Provincial legislation, and indeed have to be ultimately approved at the Provincial level of government. It is, however, possible to pass by-laws that are perhaps based on questionable authority, but such by-laws will remain in force until such time as they are successfully challenged. Challenges may indeed prompt the Province to reinforce such a by-law if it clearly reflects an appropriate public intention.

Development Control Mechanisms

The extent to which the City can regulate the impact of development upon the environment depends upon the point at which an application enters the development control system. At the building permit stage, the City's ability to secure measures appropriate for the environment, or the mitigation, or the amelioration of environmental impacts, is minimal. At higher levels of the system of development control, the City is able to exercise greater and greater authority with respect to environmental matters.

Building Permits: If all that is required to develop a parcel of land is a building permit, then the applicable controls over environmental matters are those that are implicit within the Building Code, plus those that are specified in City By-laws, and those that are specified within Provincial legislation. The City's Chief Building Official has a responsibility to issue permits for any proposal which meets the requirements of the Building Code and the Zoning By-law and other relevant legislation, regardless of any environmental concerns that might arise.

Committee of Adjustment: The Committee deals with site specific minor variances such as changes of density, setbacks, or the expansion of non-conforming uses. The Committee has the authority to impose conditions on the granting of variances which could include environmental conditions, such as landscaping and buffering requirements between heavy industry and residential land uses. However, these applications are not routinely reviewed by civic staff in a systematic manner. Applications may, therefore, occasionally "fall between the cracks".

Development Review: This mechanism of review is imposed only in specially designated areas that are subject to Site Plan Control. Within the City of Toronto this includes the Central Area, commercial strips, certain industrial districts, and major redevelopment areas. Where new industrial commercial and large scale residential development occurs, apart from minor additions or structural alterations, plans are required to be submitted to the City and the owner must enter into a development agreement with the City covering the following matters: massing and conceptual design of a building; relationship of the proposed building to the streetscape and publicly accessibly spaces; road widenings; access ramps; parking and loading facilities; landscaping; lighting; garbage and waste storage facilities; and disposal of storm surface and waste water.

In certain instances, the City has also required sun-shade and wind studies for major developments under Section 40 of the Planning Act, although there was no explicit authority to do so. Recently, the City has begun requesting waste reduction and management plans for major developments under Section 40, again without any explicit authority to do so. There are proposals under current discussion within the City to request energy efficiency plans for major developments, also without explicit authority to do so. Lacking appropriate authority, the City secures these plans with collateral agreements which are not as secure as Section 40 agreements.

Developments that are identified as occurring on contaminated soil sites, or if they have been identified in any way as including any potentially adverse environmental impacts, are routinely submitted to the Environmental Protection Office for their review and recommendations as to appropriate mitigation measures.

Rezonings and Official Plan Amendments (OPA): A rezoning application can either be required in order to change a permitted zoning to another permitted zoning within the Official Plan (OP), in which case it can proceed without requiring an OPA, but if the zoning change also requires a change from the policy specified within the OP, then an OPA is required. In this latter case, a greater degree of review and control of environmental considerations is possible.

In the case of a rezoning to permit development as allowed under the Official Plan, specific rezoning criteria may already be established which will form the basis upon which the rezoning application is evaluated. In some instances, these criteria may deal with environmental impacts as related to such issues as: sun and wind conditions; appropriate residential environment; soil testing and remediation; and buffering and landscaping to enhance compatibility between uses.

Within the City, certain categories of rezoning, whether or not an OPA is involved, are routinely circulated to the City of Toronto's Environmental Protection Office for their comment and recommendation. These include applications involving sites which are known or suspected to be contaminated, industrial sites to be developed, and residential development adjacent to industrial areas.

Routinely, whenever an OPA is requested, the following issues have to be addressed by the applicant: noise impact statement; sunshade and wind studies; waste reduction and recycling; and wherever it is appropriate, the applicant must also submit soil testing and disposal plans and construction management plans.

Sub-division Control (Section 50): Although rarely used within the City of Toronto, Section 50 of the Planning Act provides that the health and safety of present and future inhabitants and the protection of the natural environment can be considerations in the drafting of sub-division agreements. Normally, these agreements include clauses to ensure the preservation of valley lands, trees, and noteworthy features; noise attenuation struc-tures, especially near highways and railway lines; the safe disposal of storm, surface and waste waters; and the mitigation of the impacts of construction activities.

Holding Provisions: Special provisions have also been applied as in the Railway Lands which attempt to mimic the powers available under Section 50 of the Planning Act. Using Section 35 (Holding provisions), the City was able to set the specific conditions which must be satisfied before the underlying development rights can be accessed. These conditions include, among other things, the provision of roads and other physical infrastructure, conveyance of land for housing and parks and environmental remediation. Before the "H" can be removed, the following must be submitted and approved: a precinct plan; a precinct agreement; an environmental report; an environmental agreement; and a concept plan.

In addition, special legislation under the City of Toronto Act, which applies only in the Railway Lands, enables the City to enter into binding agreements with the owners of lands with respect to all the matters noted above.

Environmental Planning in the City of Toronto

Environmental planning has not been the sole preserve of the City of Toronto's Planning and Development Department. Relevant work has also been undertaken by the City's Public Works and Environment Department, Public Health Department, and Parks and Recreation Department. Environmental planning issues have traditionally been addressed piecemeal within the City, both among these various Departments, and within the Planning and Development Department itself. Their collective accomplishments are, however, considerable, and include such policies as: ravine protection, waterfront plans, municipal storm and waste sewer systems, and the various environment related By-laws such as those that relate to noise, smoking, and CFC's. However, a clear and comprehensive policy direction is only now emerging as part of the Cityplan '91 initiative.

Despite the very strong initial link of environmental matters and town planning in Canada, the planning profession emerged into the 1970s as a policy making and development reviewing process that in urban centres was seemingly without any significant awareness of matters pertaining to the environment.

Initially, the link between environment, environmental health, and urban planning had been strong – as under the guidance of Thomas Adams who as the Town Planning Advisor to the Canadian Commission of Conservation (1909 - 1921) was also the head of the Commission's Public Health Sub-committee. However, with the demise of the Commission, little advancement was seen until the years following the "Wall Street Crash" and the ensuing "Dust Bowl" years. During the 1930s the central role of environmental planning was again evident in such Federal-Provincial, large-scale, and rural, schemes as were begun in the Prairie Farm Rehabilitation Act; but environmental planning passed most urban centres and smaller municipalities by. The next period of environmental awareness that is clearly evident among those that were engaged in "town planning", as throughout Canada, Ontario, and the Toronto region, largely centred around the writings of such authors as McHarg, and specifically around his systemic planning and environmental overlay method of assessment as expressed in *Design with Nature* (McHarg, 1969) and elsewhere. However, in large measure the new philosophies and ethics that accompanied the Second (1930 - 1939) and Third (1945 - 1960) Conservation-Environment Movements passed planning by. In this regard Toronto was far from alone.

Urban environmental planning within the City's Planning and Development Department could be said to have begun in 1976 with the advent of the environmental inventory completed as part of the 1976 Waterfront Plan. Further impetus was provided in 1980 when a program of "bicycle and environmental planning" was introduced. Initially, greater effort was required and expended in bicycle planning than in environmental planning; subsequently in 1987, however, the program was subdivided, environmental planning became a separate component of the planning process. Urban environmental planning became a more significant and integral component of the Planning and Development Department with its incorporation in 1989 at the inception of the Cityplan '91 process of Official Plan review.

Today, urban environmental planning within the Cityplan '91 context has considerable potential and opportunity to generate a comprehensive set of appropriate environmental policy statements that will preserve and enhance the health and well being of the City's natural environment and the health and well being of all its residents, workers, and visitors. Urban environmental planning in the City of Toronto ought to continue to be innovative and to play a leadership role in the environmental affairs of the City. This should be done in close harmony with the other environment-interested public agencies of the City, and with the benefit of their expertise and goodwill. Environmental organizations need also to be used to the fullest extent possible to ensure that the policies and activities of the City are indeed "environment friendly", and as current to the available public demand as possible.

It is worth remembering that although the most effective form of planning policy is often the one that prohibits a particular development form or activity; the placing of restrictions on people and their proposed developments often leads to greater restrictions being placed upon the process of good sound, common sense, planning. Less room may be left to reach a consensus or to manoeuvre toward a mutually satisfactory compromise, or indeed to satisfy a general environmental and social improvement that does not fit the preconceived list of possibilities. This should never, however, be regarded as a reason or excuse to ignore the very significant needs and environmental concerns of the public and their city's environment.

Finally, although the City has much that it can achieve, the preferred scenario for an improved environment in the City of Toronto may well include the Province rationalizing its legal authorities. Currently, public developments are subject to the environmental review and approval procedures as specified under the Environmental Assessment Act, however, private developments are subject to the development review and approval process as specified under the Planning Act. The public clearly expect the city to be planned, and equally clearly expect environmental planning to be a central component of that planning. That the two processes available for development review are not applied equally to all undertakings is largely unknown to the public. The common assumption that the two processes operate in tandem, whilst largely incorrect, does, however, strengthen the need for official planning policies and controls that are environmentally conscionable.

It is fully intended that the ***Environmental Backgrounder Part II: Environmental Planning Policy in the City of Toronto*** will address the questions of how appropriate and adequate are the present policies and controls pertaining to the environment, and what new policies and strategies of implementation should be considered for inclusion within the updated Official Plan for the City of Toronto. Recommendations will address the question of provision of environmental policies that collectively address the protection of natural areas, the reduction of pollution emissions and residues, the preservation of scarce resources, and the maintenance of pleasant ambient city environments.

Photo: Vince Pietropaolo

References

Camp, T.R., & Meserve,R.T., 1974, *Water and its Impurities*, Dowden, Hutchinson, & Ross, Inc., Stroudsburg, Pennsylvania.

City of Toronto, 1988, "Toronto: State of the Environment", *Department of Public Health*, May 1988.

City of Toronto, 1989, "City of Toronto Sewer System Progress Report No. 4, *Department of Public Works*, September 1989.

Estrin, D., & Swaigen, J., 1974, *Environment on Trial*, 1st edition, Canadian Environmental Law Research Foundation, Toronto.

Estrin, D., & Swaigen, J., 1978, *Environment on Trial*, 2nd edition, Canadian Environmental Law Research Foundation, Toronto.

Gould, R., 1989, "The Exhausting Options of Modern Vehicles", *New Scientist*, pp. 42-47, 13 May 1989.

Lang, R., & Armour, A., 1980, *Environmental Planning Resourcebook*, Lands Directorate, Environment Canada.

LRPD, 1970, *Local and Regional Planning and Development*, Governor's Task Force Report, West Virginia, Regional Review, National Service to Regional Councils, Washington, D.C., January 1970.

Marsh, W.M., 1983, *Landscape Planning: Environmental Applications*, Addison-Wesley Publishing Company, Don Mills, Ontario.

Mather, A.S., 1986, *Land Use*, Longman Group U.K. Limited, London and New York.

McHarg, I.L., 1969, *Design With Nature*, Natural History Press, Philadelphia.

Meadows, D.H., Meadows, D.L., Randers, J., & Behrens, W.W. III, 1972, *The Limits to Growth: A Report for the Club of Rome's Project on the Predicament of Mankind*, Potomac Associates, Universe Books, New York.

Miller, G.T., Jr., 1988, *Environmental Science: An Introduction*, Wadsworth Publishing Company, Belmont, California.

Oke, T.R., 1978, *Boundary Layer Climates*, Methuen & Co. Ltd., London.

Oliver, J.E., 1973, *Climate and Man's Environment: An Introduction to Applied Climatology*, John Wiley & Sons, Toronto.

Ortolano, L., 1984, *Environmental Planning and Decision Making*, John Wiley & Sons, Toronto.

PACE, 1985, "Submission to the Royal Society of Canada, Commission on Lead in the Environment, on Petroleum Refining by the Petroleum Association for the Conservation of the Canadian Environment", [PACE], unpublished submission.

Rees, W.E., 1989, "Defining *Sustainable Development*", *CHS Research Bulletin*, May 1989, UBC Centre for Human Settlements, The University of British Columbia, Vancouver.

Ross, P.E., 1990, "Clean-air Fuels for the '90s", *Popular Science*, January 1990.

Rubin, C., 1989, *How to get your lawn and garden off drugs*, Friends of the Earth.

Salvatato, J.A., 1982, *Environmental Engineering and Sanitation*, 3rd Edition, A Wiley-Interscience Publication, John Wiley & Sons, Toronto.

Todd, J. & Tukel, G., 1981, *Reinhabiting Cities and Towns: Designing for Sustainability*, Planet Drum Foundation Publishers, San Francisco.

WCED, 1987, *Our Common Future*, publication of The World Commission on Environment and Development [WCED], Oxford University Press.